THE TRUE BOOK ABOUT DESERTS

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THE TRUE BOOK ABOUT DESERTS

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Chapter One

HOW DESERTS GROW

On a map of North Africa there is a large area marked "Sahara", the largest desert in the world. It stretches from the Atlantic through the thickest part of Africa to the Nile Valley. The Sahara Desert is twenty-five times as large as the British Isles, a vast barren waste of sand, a place where the days are very hot and the nights equally cold, where little will grow and where the only human inhabitants are small groups of people living out a hard existence. The mere word "desert" conjures up in our minds an endless stretch of burning sand, with the sun blazing down from a cloudless sky and not a drop of water except in oases, which are few and far between.

Certainly that is a true picture of one kind of desert, but deserts may be of many kinds. To begin with there are cold as well as hot deserts, while other deserts are hot in summer and cold in winter. The cold deserts are such as the continent of Antarctica and the ice-cap of Greenland, where the ground is ice- or snow-bound all the year round. Very clearly, it is not going to be easy to say in a few simple words exactly what a desert is, but we can say this, that all deserts, wherever they may be, are dry with very little rainfall. This does not mean that a desert is without water. In the cold deserts like the continent of

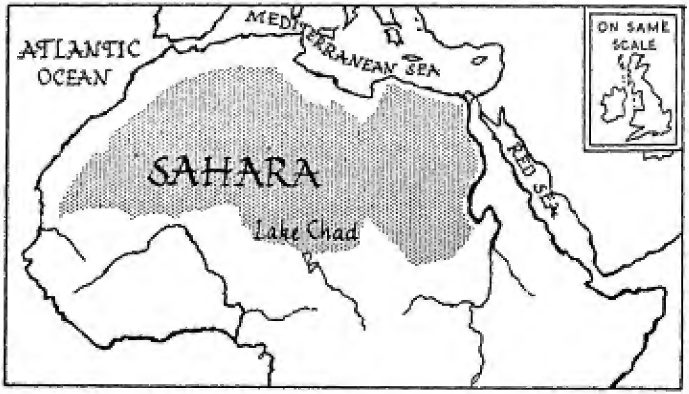
Antarctica there is plenty of water, but it is locked up as ice. In the other deserts there are underground rivers and reservoirs.

It would also be wrong to think of a desert as a place where there is no vegetation at all. Parts of some of the large deserts are like that but in other parts there is a scanty vegetation, enough to support a few animals, and enough in some places to provide a livelihood for scattered tribes. As a rule, however, the people living in deserts stay around the oases, which are not strictly part of the desert, or they draw their supplies from areas beyond the desert, trading as best they can with those living in the more pleasant lands, or else they wander from place to place—we call such wanderers nomads, and we speak of them as nomadic tribes—moving into areas where rain has recently fallen and then moving out again.

When rain does fall in a desert region it is not as gentle rain such as we know but as a cloudburst. And after the cloudburst the desert blossoms like a rose, but only for a short time. During that time, however, the nomads can move in, graze whatever animals they keep, and move out again as the vegetation dries up. Some of the things we are going to talk about are how the plants manage to survive at all, and why it is that after a fall of rain carpets of flowers appear, although there may have been no rain in that part for five years or more. What we shall learn will be a most remarkable story of how the seeds can bide their time until exactly the right conditions are there for them to germinate and grow into plants which blossom and shed their seeds before the blazing sun has dried everything up again.

We shall also be inquiring into the way animals can live in the deserts. All animals require water, yet there are

some animals that never drink. It has long been a puzzle to know how they managed this, and one of the most romantic stories in modern research is how scientists found the answer to this. But water is not the only problem animals have to solve in order to live in deserts. They have to avoid the heat or else find some way of living through it. They have to be able to move over sand that



Map of North Africa

shifts under their feet at every step, or would shift if they were unable to move in such a way as to avoid this.

Before we get to these things, however, we need to know more about the deserts themselves, to get a clearer picture of deserts as a whole. One thing we must always remember is that is desert is not just a stretch of sand at the edges of which we suddenly come upon green pastures or lush forests. In parts of the main deserts, as we have seen, there may be some vegetation, and on the borders of the desert proper are dry lands that gradually merge into areas of ordinary vegetation.

If we look again at our map of Africa showing the Sahara desert we see in its south-eastern corner a small patch of blue. This marks a lake, known as Lake Chad. It is 6,300 square miles in extent, or three-quarters the size of Wales, yet in spite of its size it is nowhere more than forty feet deep. Lake Chad has no outlet and it is fed from rivers running down from the grasslands and forests of Central Africa to the south. It is, in fact, the centre of an enormous drainage of water. Even so, Lake Chad is gradually drying up.

Although this lake marks the southern limit of the Sahara its rainy season is in summer and the country around it is not an unbroken sea of sand but is dotted with flat-topped acacia trees and an occasional thick-trunked baobab, and there is enough grass for the people living there to feed their cattle. These are humped cattle with long curving horns.

The people of the Lake Chad area are a mixed race. Some have the broad faces with squat noses of the negro and others have thin faces with aquiline noses. They are a mixture because the Hausa people, a North African race related to the Ancient Egyptians, were the first to settle there, but they were conquered in the nineteenth century by the Fula, a negro race from Senegal in West Africa. If it was worthwhile for the Hausa to migrate southwards from North Africa and to settle there, and for the Fula to come across from West Africa to conquer them, there must have been something in the region to attract them. The fact that these people now live in villages of round mud huts shows that they are not nomads, and suggests that they may have known better times. For the truth is that the Sahara is steadily creeping towards and surrounding Lake Chad, and the people

living there are now on the fringe of a desert life which looks like getting worse, although their ancestors, living in this same region, probably had all the vegetation they needed.

This is rather a new idea, that the Sahara is getting bigger, and it is one we have awakened to in fairly recent times. But not only is it getting bigger now, it must have been growing in extent for a very long time. We can, in fact, be quite sure that at one time the Sahara was very small because right in the middle of what is now barren desert rock, carvings are found of cattle very like those owned today by the people of Lake Chad. Such cattle could not have been herded there if the vegetation had not been at least as good as that around Lake Chad today. Not only are rock carvings found but there have been unearthed in the Sahara flint implements, bone tools and ornaments made from ostrich shells. These were made by prehistoric man, and they are fairly certain proof that ostriches once ran wild where today the desert is barren. Ostriches can live in dry areas but they must have some vegetation at least to feed on, and if prehistoric man lived there we may be fairly sure that there was more than ostriches to attract him.

So the story of Lake Chad raises the whole question of how deserts begin, and what causes them to grow. The answer is that it may be due to climate but it can also be the result of man's activities. The centre of a continent is that part farthest from the sea. Winds coming in from the sea carry water vapour which in due course falls as rain. The farther the winds have to travel over the land, especially where there are mountain ranges in their path, the less water vapour they carry and the less the rainfall. But the Sahara is not only in the centre of the continent

of Africa, it also stretches from the Atlantic to the Nile Valley, so what has just been said must be explained.

On the coast of Africa where that huge bulge thrusts itself into the Atlantic the prevailing winds are offshore. It is, therefore, not only a question of distance from the seaboard and of what mountains lie in between. The position of a desert also depends on the direction of the prevailing winds. When we are considering the history of a desert, also, we have to take into account that climate can change during the course of centuries. It is changing today over the British Isles, very slowly, so that we are not readily aware of it, but there was a time when there was desert over parts of Britain, although this was a very long time ago.

However, climate can cause deserts, and changes in climate can cause deserts to appear and disappear. Man also can cause deserts, and he is doing so in many parts of the world today. If he puts too many sheep on pasture, especially where the grass is poor or the rainfall low, they can overgraze the land, killing off the grass and exposing the soil beneath. With the weather dry and no vegetation to bind the topsoil, the winds begin to loosen and finally lift the soil, carrying it away. Heavy rainstorms gush water on to the surface of the earth. With no vegetation to trap the rain or impede its progress, the water flows away carrying soil with it into the rivers and finally into the sea. This is what is known as soil erosion. It can come as a result of bad farming or bad husbandry.

In some parts of the world the people use a very primitive method of tilling the soil. They select a strip of forest land. They cut down the trees or just burn the forest, then they plant crops on the land they have cleared. They keep on planting crops until at last the soil is so poor

they can grow no more crops, and even the weeds fail to grow. Then another strip of forest is chosen and burned, to be cultivated. Meanwhile, the topsoil on the first strip is being blown away by the wind and washed away by the rain and a young desert is already being born.

There is reason to believe that the growth of the Sahara has been hastened by the over-grazing of the lands round its borders by sheep and goats. All the same, this must have been a long time ago, for the Sahara was there, and must have been large, in the days of Ancient Rome. We know this because the Romans conquered North Africa and colonized large parts of it. They also irrigated the desert, and the canals they made can be seen today.

We have seen how the area around Lake Chad is now a semi-desert and how the semi-deserts created by man's bad handling of the soil can become real deserts, nothing but a barren waste of sand. But not all barren deserts are covered with sand. Sometimes the surface is just bare rock or boulders, or it may be gravel. Sand consists of grains, each grain a particle ground from rock. The formation of sand can be brought about in several ways. The sands on the seashore are made up of minute grains formed as the waves pound the cliffs and roll the boulders about, breaking them into smaller and smaller pieces. Wind can do much the same. For example, in some parts of the sandy deserts the surface is nothing but bare rock, its surface smooth and polished. High winds lift particles of soil or sand and brush them over bare surfaces. You can see old silver spoons worn thin, or brass door knobs rubbed bare, from years of polishing. Particles have been worn off, so fine that we cannot see them. The wind laden with sand does much the same to solid rock.

We see the effect of the wind best where there are

boulders in the desert. The wind nearest the ground being the most heavily laden with particles, the boulders are chiselled away at the base so that they are top-heavy, from being scoured and polished by the dust-laden winds. We can see it also in the way a desert wind will lift the dry soil and swirl it along, in what are called "desert devils". Even worse is the sandstorm, or "simoom", when hot air at 100° F. or more is driven with great force carrying choking clouds of hot dust and sand so dense that it is impossible to see for more than a few feet ahead.

Changes of temperature also help to break up the rocks to form boulders. The boulders become broken up into gravel, and the gravel into sand. All deserts have a wide range of temperature, and it is easy to see why. If we look at the sky on an autumn evening and see it studded with stars we can be fairly sure there will be a frost. When the sky is cloudy the weather may be unpleasant but a frost is unlikely, because the clouds act as a blanket to prevent heat escaping from the land beneath. Cloud often forms in the afternoon over a hot desert, although this does not necessarily mean rain, but the nights are clear, with a star-filled sky. The dry soil takes in heat quickly from the sun during the day, and the air at ground level heats up rapidly as the sun rises in the sky. Once the sun sets, the soil, whether sand, gravel or rock, gives up its heat equally rapidly and the temperature of the air drops. With the change from the hot blistering days and the cold nights, rock, pebble and gravel first expand rapidly and then, at night, contract rapidly. In time, the strain is too much and something gives way. Cracks appear in the rocks, or cracks already there grow larger. And if there are not actual cracks formed the rock develops lines of weakness. And what happens in the rocks also takes place

in boulders, pebbles and gravel, helping them break up into smaller and smaller pieces. The process may be extremely slow, but it is none the less sure.

Rock, worn by wind and sand to form this arch which stands at Utah

How hot the desert can be during the day can be best explained by what we sometimes see on our roads. On a hot summer's day, especially on a road worn smooth by traffic, the air above the surface of the road seems to shimmer. In the desert, the very hot air rising from the

surface of the ground causes a shimmering haze which plays tricks with the eyes. Thirsty travellers in the desert have seen what they thought was a lake only to find, as they journeyed on, that it was a mirage, a trick of light that makes things appear where they are not.

The sands of a desert do not lie in a flat plain but are blown by the wind to form ripples and waves, ridges or dunes. The dunes, or sand-hills, are crescent-shaped with long gentle slopes facing the direction of the wind and a steep slope on the other side. But even the dunes are little better than slow-moving waves. The wind carries the sand up the gentle slope, over the crest of the dune to fall down the steep slope on the other side. So the dune slowly moves along before the wind. So, also, is the face of the desert always changing, and this is one reason why travel across a desert is so difficult and why people can so easily lose their way. There are few landmarks, and what there are may easily be lost in a short while. In some deserts where there are shrubs, as in the deserts of the south-west U.S.A., where the creosote bush grows, these often become partially buried by drifts of sand, so that what was once a well-grown bush becomes a pile of sand with branches growing out of the top.

Now we can see why people living in desert regions prefer to travel by night. Not only is the air cool but the skies are clear and they can find their way by the stars. They also prefer to travel along the beds of dried-up streams, known in the Sahara as wadis. They have steep sides, up to thirty feet high, which give shelter from the wind.

So far we have dealt almost entirely with the Sahara, a desert of flinty plains and granite mountains rising in places to 10,000 feet, and plenty of sand, often in

treacherous patches, and with occasional oases with palm trees and water. To the north of it is the fertile strip of North African coast, to the south the dense rain forests and the savannahs, or grasslands, of Central Africa. Eastwards from the River Nile the desert continues, across Arabia and northwards into Israel. In southern Iraq, too, there is desert, and from there, across the Persian Gulf, we go into Asia. Continuing eastwards we soon come to the Thar desert in Pakistan. The Sahara

Sand dunes in the Sahara

has been described as the hottest desert in the world. There the temperature by day may be 120–130° in the shade. It may be the hottest taking the average but in the Thar desert has been recorded the highest temperature in the world, 148°. To the north and westwards, from the Thar desert, across China, we come to the famous Gobi desert, one that is hot in summer and bitterly cold in winter. And northwards from the Thar lies the Aral Sea, in the Soviet Union, with deserts flanking it on both its shores.

There are other famous deserts in the world, and two

that are less well known. In South-West Africa is the famous Kalahari desert. There live the bushmen, primitive Africans, very small men that have hardly progressed beyond the bow and arrow, who have never learned to build a hut but dig a hole in the ground with a skin covering over it for a roof. The bushmen are friendly people, but defenceless against the march of civilization. The desert is for them a refuge.

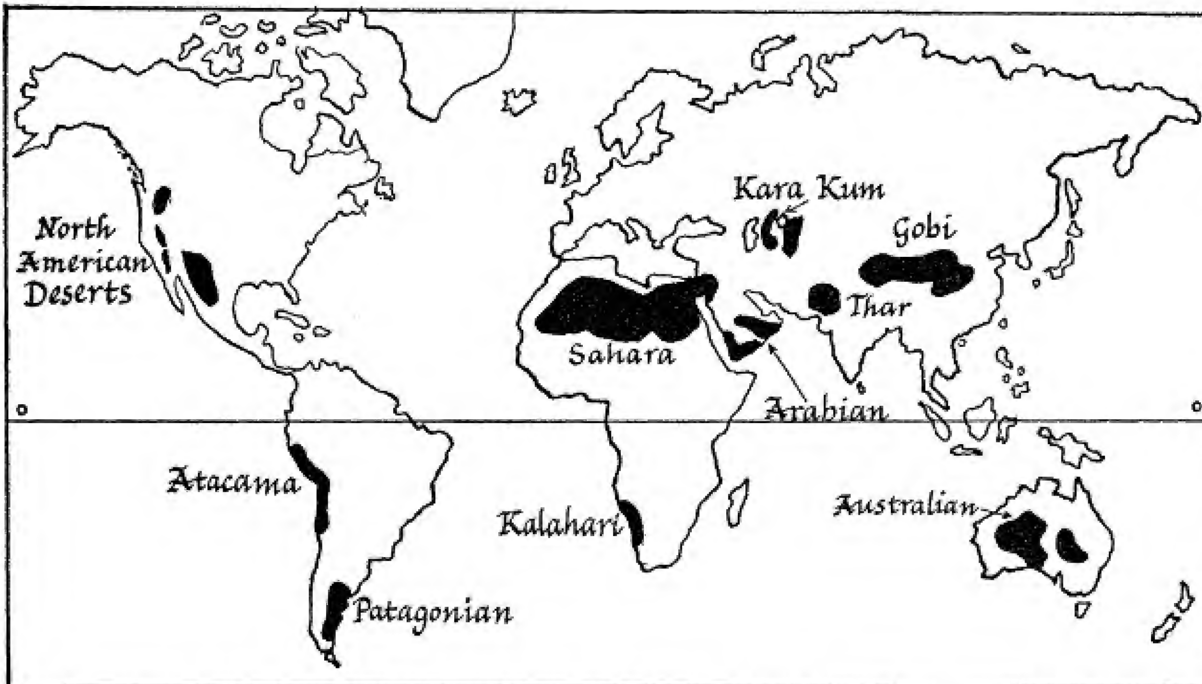
In central Australia is another large desert, inhabited by aborigines, nomads who, like the bushmen of the Kalahari, have advanced little beyond the Stone Age. For them, also, the desert is a refuge.

North America has its deserts, well known to those who follow the "Westerns" since they lie to the south-west of the U.S.A., in Arizona and Nevada, and in southern California, and from there spilling over into Mexico. In South America there is a desert along the western coast, one between the waters of the Pacific and the Andes mountains, and another in the south-eastern tip of South America, the Patagonian desert.

In the following chapters we shall take a closer look at all these in turn, especially at their plants and animals and the ways they have for surviving the heat and the dryness. Before doing so let us see what these two words mean in terms of maintaining life. I have stressed the extreme changes of temperature found in deserts, from the intense heat by day to the very cold nights, and the lack of water. And yet there is plenty of water, strange as it may seem.

The water in a desert comes from three sources: rain, underground rivers and dew. Let us examine these in turn.

In this country the amount of rain falling in a year may



Map of the world with main deserts shown in black

be as low as 25 inches or as high as 100 inches. As much as 9.56 inches have been recorded in one day, and on one occasion 2.24 inches fell in forty minutes. In desert areas it may be as low as 0.3 inches or as high as 2.3 inches in a year. But these are averages, there may be no rain in a given spot for two, three, or five years, and when it does come it comes all at once, in what we call a cloudburst.

It is not rainfall alone that matters, but what happens to the rain when it falls, what we call the effective rainfall. We in this country are used to gentle rains in which the water falling on the earth gradually makes its way down into the soil. And after a fall of rain the earth remains damp for a long time. There are occasions, after a long spell of dry weather, when the first rains moisten only the surface of the earth, for two reasons: the first drops merely cake the surface of the ground and the rest following runs off and finds its ways into the rivers, or it may be that some of the water falling as rain is evaporated by the warm air and the warm soil. In a desert, where the soil is always hot by day, heavy rain falling in a cloudburst soon begins to evaporate and what is left runs off. It gushes into any gulley or depression, or into the dry water courses, known as wadis in some places and as dry washes elsewhere in the world. Even this gushing water is later spread out thinly over the surface after it leaves the wadis and being evaporated leaves behind crystals of various salts, including the one we call common salt. Some of the water will remain in the wadis keeping the soil moist there for several days, and during this time quick-growing plants spring up and flower. The final result is that there are patches where the soil is covered with a layer of salt crystals sparkling in the sun and

patches where the flowers are blooming as we see them here in spring.

We know that under the surface of the earth in the deserts there are rivers and reservoirs of water. These may be at levels of three feet down, twenty feet down or even as much as 120 feet down, or at any depth between these. There may be several layers of water at different levels. What we are not sure of is how the water has got there. Some, the rivers, has probably come from areas of high rainfall outside the desert, having soaked through the earth and then travelled below the surface. Some of these underground levels of water may be old rainfall levels, dating from the time when this part of the world was not desert, and possibly held there by a layer of air trapped in the spaces between the grains forming the soil.

When the underground waters are too near the surface, that is, less than thirty feet down, they are drawn up through the soil by capillary action, evaporated and, again, salt is left behind. This does not mean that the water to begin with was too salty for drinking or for irrigation. It is what happens to it at the surface that matters, and if it is to be used for irrigation something must be done to prevent evaporation. When the Romans were reclaiming the deserts in North Africa they constructed large rock cisterns underground, from which the water could be taken when needed. Today various methods are being tried to cover reservoirs with materials that will reflect back the sun's rays and so prevent evaporation. The trouble is to find something that is cheap to use and yet will stay in position when the fierce winds sweep across the desert. We shall be having more to say about reclaiming deserts, that is making them fertile so that crops can be grown, in the last chapter. Meanwhile, it does no

harm to mention that the problem of what to do about deserts is a very old one. At various times different peoples have tried to solve the problem, and in between these times other peoples have created new deserts.

In addition to the Roman rock cisterns there are in the Sahara what are known as foggaras. These are found in the area of the Touat, which is an area about three-quarters the size of France. Each foggara is a canal dug below the surface of the desert which may be as much as ten miles long, and at intervals there are vertical shafts running to the surface and beyond it. The part of the shaft above the level of the ground is circular, built of rock and about three feet high, so that they look like a line of wells without the windlasses. Altogether there are about a thousand miles of foggaras, running under the ground like our modern tunnel-system for underground railways, and marked by a line of circular well-tops at the surface.

Nobody knows for certain who built these, or when, or what means were employed. It seems most likely that they could have been built by slave labour, as the pyramids were. It is believed that Jews living in what is now Libya, during the second century A.D., fled south from the cruelties of the Roman Emperor, Trajan. They appear to have built this underwater system of canals connected to the wells, as we have seen, in order to water the land to grow crops, especially date palms.

The people of this area were Berbers, and they and the Jews seem to have lived together on good terms and to have shared the prosperity brought by tapping the underground waters of the desert. Then, towards the end of the fifteenth century, a race of Berbers from the north, who had settled in the Touat and enjoyed its prosperity, became imbued with a religious zeal and massacred the

Jews. Prosperity continued for a while, but before long the Berbers were fighting among themselves, the trade caravans no longer went out with their produce, and the wonderful irrigation system fell into disuse, but not into decay, for the canals and the wells still stand and the inhabitants of the region still use the water from them.

This is not the only time that the Jews have had to make the desert serve them. When the Children of Israel were in the Wilderness—which is only another name for desert—they made use of the dew, and the piles of pebbles employed in this can still be seen. Dew forms best two or three feet above the level of the ground, so pebbles were piled to this height, on which the dews could condense. Once the water was formed it trickled down the pebbles on to the ground beneath. Then, during the heat of the day the pile of pebbles shielded the ground beneath from the direct rays of the sun, prevented evaporation, and thus preserved a patch of earth that was continually moist, where shrubs and trees could be grown. It is not surprising therefore to find that the Israelis today are doing pioneer work in making their deserts bring forth crops, and, as we shall see later, they use dews for this.

Chapter Two

DESERT PLANTS

ANIMALS depend on plants for their food. Even those that prey on other animals are merely taking their plant food at second-hand since they are feeding on animals that themselves feed on plants. The kind of plants we find in any particular place are dependent on the climate and soil. We have already dealt with the climate and the soil of deserts. The next step, therefore, is to consider the plants.

A plant lives by taking water in through the roots. This passes up through the stem and into the leaves, and some of it is then lost through small openings, or stomata, in the leaves. In other words, a plant is constantly taking in water and losing it to the atmosphere. Therefore, the more water taken in by the roots the more the plant can afford to lose; the less the roots take in the less must be given off through the leaves. Plants living in dry situations, and known as xerophytes (Greek: xeros = dry, phyton = plant), have various ways by which the loss of water can be reduced. Their leaves may have only a few stomata, and these may be sunk in grooves or pits, and the grooves and pits may be protected by hairs. More usually the size of the leaf is reduced and its surface protected by a tough cuticle. In deserts, which are the dryest places, the leaves of trees and shrubs are either stiff and hard, as in the

palms, or they are very small, often no more than spines, as in cacti.

To make the most use of what water there is, desert plants have long roots either to go down deep or to spread out under the surface, or else they store such water as the roots can get in fleshy roots, or have bulbs that achieve the same end. Those with fleshy stems are known as cacti, a

Death Valley in Southern California

name which strictly speaking should be used mainly for American desert plants with fleshy swollen stems and leaves converted into sharp spines. There are others very like them in the deserts of Africa and elsewhere that are known as succulents. The distinction between true cacti and succulents is a technical one and the two names are often used loosely, so we need not be too particular here about how we use them.

In addition to the dry shrubs and trees known as xerophytes, the cacti and the succulents, there are other flowers in the desert, small herbaceous plants that manage to survive because they have a short growing period. These are very like the ordinary herbaceous plants in our gardens to look at, but the whole plant lasts only a few weeks. Their seeds germinate, the plants grow, flower and produce their seeds immediately after a fall of rain. After that the plants dry up and the seeds lie dormant until the next rains.

We can best understand how these various desert plants live by examining in detail some of the different kinds. For this we can do no better than go straight away to Death Valley, in southern California. This lies near the border with Nevada. The valley is long and narrow, flanked by a range of mountains on either side, and to the west of it there is another tall screen, the Sierra Nevada mountains, which catch the water vapour brought in by the wind blowing from the Pacific. As a result the rainfall in the valley averages 1.35 inches a year. There is no surface water, such as streams, pools or springs, and since the level of the valley is below sea-level salt has accumulated in its central part, the ground there glistening in the sun where it is coated with salt crystals. No plants can grow in this salty area, but around it are green shrubs, the mesquite, and this is green because it can send its roots down to as much as a hundred feet below the surface, to tap the underground springs fed by waters coming down the mountain sides and running underground.

The mesquite is, however, not the only remarkable plant in Death Valley. There is one, a shrub known as *Peucephyllum,* which seems to be able to live without water, although how this can be is very difficult to know.

Another, the white-leaved holly can grow fairly well in salty soil, but not where the crystals encrust the surface.

Another remarkable plant in Death Valley is the creosote bush, an evergreen. This, instead of sending its roots down deep, spreads them wide so as to draw upon a large volume of soil for its water. And one of the most striking things about the creosote bushes is the way they are evenly spaced over the desert, as if they had been planted by somebody who had measured out the ground. The reason for this is of especial interest because it helps us to understand why desert plants are as a rule well spaced out.

When water, or anything else, is scarce the only reasonable thing to do is to share it out evenly. The more there are to share it the less there will be for each one. Many desert plants have a water-sharing system which works automatically, and one of the plants that uses this system is the creosote bush. It works in this way. The roots give off small amounts of poison which prevents seeds from germinating. These poisons are known as inhibitors. They inhibit, or prevent, the growth of other plants. They do not poison the soil all round but only in the immediate neighbourhood of the roots that give them off.

The inhibitors not only prevent seeds from germinating but they also stop the roots of other creosote bushes from growing out too far. The result is that the bushes are growing at equal distances from each other.

Spreading roots, such as those of the creosote bush, are at a disadvantage as compared with those of the mesquite that can travel far down into the soil. If there is a longer period than usual between rains the topsoil dries out even more than usual. When this happens the creosote bush uses another safety measure. It throws off its green leaves. It is then left with small brownish-green leaves that up

till now have been hidden under the green leaves. The brownish leaves do not allow so much water to escape from their surfaces as did the green leaves, so the bush is able to economize in the use of water and to carry on for a while even though the ground is drier than usual. This cannot go on indefinitely, however. The brown leaves are less efficient than the green and if the period between the rains is too long the bush finally dies.

The next time it rains, the water washes down through the soil around the dead creosote bush and carries away the inhibitors from the roots. The soil is now clean again and seeds shed by the dead bush that have been lying on the surface can now germinate. As each of the seedlings throws out its roots the inhibitors are given off once more and eventually only one of the seedlings survives, to take the place of the parent bush that died.

In certain parts of Death Valley there are dry river beds, or dry washes. These are similar to the wadis of the Sahara. In them grow smoke trees and ironwood trees, and these also are evenly spaced out, but for a different reason. The seeds from these trees are so hard that a steam hammer almost is needed to crack them. Even if these seeds are left in water for a year they still fail to germinate. Yet when the rains come it is not long before the seeds of the smoke trees and the ironwoods are sprouting. This presented a puzzle, but eventually the explanation was found, and it also explained why the trees are evenly spaced.

Although prolonged soaking fails to make the seeds germinate, as soon as their hard coats are cracked they will germinate in a day. When the rains come the water gushes down the dry washes carrying not only seeds but grains of gravel and sand. These grind the seeds, rubbing

away and splitting their hard coats, and by the time a seed has gone about fifty yards it will be able to germinate. If by that time the flood of water has subsided the seed is left on the surface of the damp ground ready to throw out its root and grow. When the flow of water is heavy the seeds are carried farther, and by the time the flood-waters subside they are so ground and crushed that they are no longer any use as seeds. The result of all this is that the smoke trees and the ironwoods are always fifty to seventy yards apart. Any seed settling nearer to the parent tree than this will not have been ground sufficiently to germinate.

So far we have spoken only of trees and shrubs. In some years Death Valley is carpeted with millions of blossoms of small plants. These have not been years of unusually heavy rainfall, as might be expected, but years following an autumn in which there had been a good rain. Some people speak of these plants as annuals, although they do not appear every year, because they are so very like the annual plants we see in the less-dry regions, as for example in our gardens. A better name for them is ephemerals, that is plants that last only for a short time. There is one big difference between the ephemerals and the annual plants with which we are more familiar, and this was discovered through tests carried out in the laboratory.

Their seeds were put on trays in the laboratory on soil taken from the desert, so that conditions could be as nearly natural as possible, and the soil was then moistened. The seeds of ordinary annuals, treated in this way, would soon germinate, but these seeds failed to germinate. The soil was then allowed to dry out again and this time the seeds were watered from above, by spraying water on to them to

represent rain falling. Now they germinated. The explanation of this was found to be that the coats of the seeds contain inhibitors, which prevented the seeds from germinating until the poisons had been washed out.

It is easy to see the value of this. If the seeds were able to germinate as soon as moisture reached them, no matter where it came from, the seedlings might start to grow and then dry up for lack of sufficient water. Dew falling on the ground, for example, might cause them to germinate. But what they really need is to germinate only in the rainy season, when there is likely to be enough water in the surface of the ground for the seedlings to get a good start before the dry weather returns, and not only to get a good start but to be able to grow, flower and seed before the water from the skies has been lost again by evaporation.

That, however, is not the whole of the story, and the mention of dew calls to mind another very important source of water upon which desert plants depend. But it can only be used by plants that are already well grown, not by seedlings. This is something we can best understand by what happens in our own back gardens during a hot dry summer. During the afternoon the lettuces and beans and other vegetable crops, as well as some of the shallow-rooted flowering plants in the borders begin to wilt, and by the evening their leaves are limp and dry looking. They are, in fact, being subjected temporarily to something near to desert conditions and they are not used to it. What actually happens is that their leaves are giving off more water than their roots are taking in. In the evening the sun goes down, the air grows cool, and by the following morning, we find that all is normal once more. The wilting has vanished, the leaves are firm again and standing up as usual. This is partly because once the sun has gone down

and the temperature has fallen the intake of water by the roots is greater than the output through the stomata on the leaves.

Even so, should the night temperature remain high the plants will still recover because they will have been freshened by dew. We can prove this by a simple experiment. If we pour water around the base of a plant that has wilted it will take much longer to recover than it would if we sprayed water on its leaves, in imitation of a fine rain. For a long time it was thought that plants only took in water through their roots and that water always had to travel upwards through the plant. Now we know that water can travel two ways. It can travel from the roots to the leaves and it can travel from the leaves down through the plant to the roots. Moreover the roots can actually give out water into the ground, and this can act as a reserve supply to be taken up again by the roots when needed. Dew forms at night. It is heaviest two to three feet up from the ground. There it settles on the leaves and not only revives them but is absorbed by them to travel down to the roots. Because desert nights are cold there is always a heavy dew, and these dews are most important to the bushes growing in the deserts.

So far little has been said about palm trees, and anyone who draws a desert scene usually puts in a few palm trees, showing how closely the two things are linked in our minds. All the same, the palms are not strictly desert plants. In the Sahara they grow around the oases, and in other deserts they grow in sheltered places, as in the desert known as Palm Springs in the Colorado desert, in North America. The desert here is surrounded by mountains whose sides are cut into deep canyons. The conditions are, therefore, somewhat different from those found in the

Sahara and the Kalahari deserts, and others of that kind. Here the snow-capped mountains contribute a fairly constant supply of water from the melting of the snow, and each canyon is a kind of oasis. Moreover, the deep sides of the canyon give some shelter from the wind.

Palm trees, whether date palms of the Sahara or the palms growing in the Colorado desert, have tall cylindrical trunks with a cluster of large frond-like leaves at the top. Deserts are noted for their fierce winds and trees of this shape, with their flexible trunks, can give to the winds, so that only a wind of hurricane force is likely to bring them down.

We have already seen that a desert is a dry place, and that it may be anything from the completely bare sandy or rocky waste that makes up so much of the Sahara to a dry area with scattered vegetation. The reason for recalling this at this point is because certain parts of the Colorado desert, where there are palm oases, are now becoming winter holiday resorts. Those who can afford to take their holidays there can be assured of sunshine, shade from the trees, and shelter from the wind.

Before leaving the North American deserts something should be said of their cacti. One of the most impressive is the saguaro cactus, with its tall, fluted main stem and branches coming off, looking like giant candelabra, anything up to sixty feet high.

It is also known as the torch cactus, because the Mexicans make torches from its stems. Another famous North American cactus is the prickly pear. Its stems are flattened and leaf-like, but swollen and succulent, and armed with stout spines. In Mexico they are planted as fences, since neither man nor cattle can break through them, although they can be used for cattle food.

The prickly pear was taken to Australia in 1839 and again in 1860, to be used for cattle food, but it flourished so much that it began to overrun the continent, smothering the other vegetation wherever it went. By 1925 fifty million acres had been overrun. Fortunately, after a while an

The saguaro cactus and prickly pear

insect was found that would feed on the prickly pear, which is now under control.

It is usually said that the spines of cacti protect them against being eaten by animals. And it is often said of desert plants generally that they are protected against being eaten either because they are dry and thorny or because they are succulent and their juices bitter or even poisonous. Clearly this cannot be true or there would be

very few animals able to live in the deserts. If we now leave the North American deserts and go across the Atlantic to the Kalahari desert in South-West Africa we shall see the plants that grow there and, later, we shall be talking about the animals, like the gemsbok, that live on them.

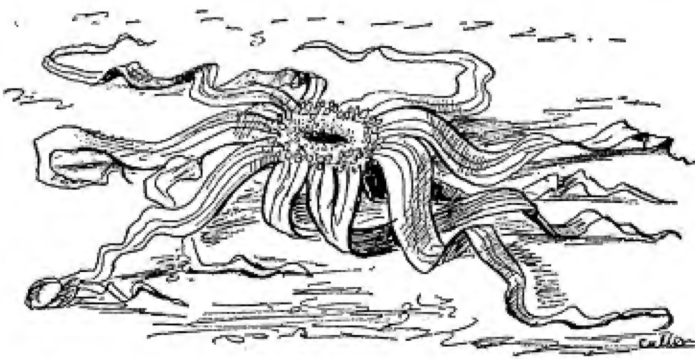
The Kalahari has its succulents, but these are not cacti. Some are tall with a main stem and a few side branches, rather like the saguaro cactus of Mexico, with both stem and branches not only fluted but jointed throughout their length. On the ground are growing smaller succulents, each more or less of a rosette of leaves, with each leaf swollen. There are a number of different kinds, and in some of these the swollen leaves are rounded like pebbles and look very much like pebbles in size and colour. In fact, if we chose to use our imaginations far enough we could say that they are protected from being eaten by animals because they look so like pebbles. That, however, cannot be the case, because they are eaten by the gemsbok and others.

In the Kalahari also grows the naras or desert melon, a woody shrub up to five feet high which throws out its roots into the sand, often as much as forty feet. Its leaves are very small and it has spines. Its fruit although called a melon is more like a grape. It is eaten by the gemsbok, by jackals and even by the Africans of that area.

The most remarkable tree in the world is found in the Kalahari, near the coast, in the vicinity of Walvis Bay. It is related to our pines and firs and is named Welwitschia, after Welwitsch, the German botanist, who discovered it. Somebody once said that if you pulled it out of the ground it would look like an enormous carrot. The top of this wooden "carrot" is eighteen inches out of the ground but it is more than three feet across and it has

only two leaves. These are like long ribbons about ten feet long and two feet across, and they are usually split into narrow strips for much of their length. The leaves lie straggling over the sand either side of the main trunk—the eighteen-inch top of the "carrot".

Most desert plants look much the same in whatever part of the world they are found. The problems that the plants have had to solve, such as scarcity of water, dry atmosphere and high temperatures, or heat by day and



Welwitschia (wooden carrot) found in the Kalahari desert

cold by night, are also much the same. It is not surprising, therefore, that they are very similar in appearance and in the way they live. There are, however, a few more striking plants from other deserts than those we have already visited.

There are, for example, plants known as Resurrection Plants. Some mosses, Selaginella by name, close up when dry and look like a bird's nest but they expand again and grow green when moistened. Such mosses have been called Resurrection Plants. The fig marigold, grown in gardens,

has also been given this name, and so has a plant from the deserts of Israel, known as the Rose of Jericho. It is only a small woody plant which, as the dry season comes on, loses its leaves, its pods ripen and its branches curl up like a bird's nest protecting the pods inside. So it remains until the rains come again. Then the branches uncurl, the seeds are shed and are washed away by the gushing waters. The Rose of Jericho has other ways of spreading its seeds, however. The plant itself grows in loose sand and is easily blown out by the wind especially while it is curled up. After that it may be blown about by the wind until it reaches a moist place, or until the rains come again, when the branches unfold and release the seeds.

Chapter Three

LARGE DESERT ANIMALS

It would have been a good thing to have taken each desert in turn, travelling around the world in imagination, describing the scenery—or lack of it in most of them—examining the plants growing there and the animals that feed on them. There are several reasons for not doing it this way. The first is that some deserts are much bigger than others and there is more to be said about them. The second is that more is known about some deserts than others. But the third and most important reason is one that has already been hinted at, that because their problems are the same the plants and animals tend to resemble each other in appearance and in the way they live. We have found this to be so with the plants and it is, to a large extent, true also of the animals. In some instances it is strikingly true. So far as the animals are concerned, we shall take them in the following order: large animals, desert rats, birds and reptiles and, finally, the insects.

If there is one animal of all others we think of in connexion with deserts it is the camel, the so-called Ship of the Desert. There is reason to believe that the camel's nickname is the result of a mis-translation and that it was originally called "the desert animal brought in a ship". It was brought west from Asia thousands of years ago,

in ships across the Persian Gulf and introduced into Asia Minor and later Africa. Whatever may be the truth of this, the name is appropriate because without the camel, journeys across the deserts would have been difficult, although today motorized vehicles are taking its place.

A great deal has been written about the loads a camel can carry, the speed it can travel, the long journeys it can make in a given time, and the way a camel will take its rider home if he is lost in the desert. The camel has been said to store water in his stomach, and some books even say that he can store water in his hump. A camel's feet are splayed, the two halves of each foot being of a spongy texture and joined by a web of skin to make travelling over loose sand easy. And much of this is incorrect.

A camel can carry a load weighing from 200 pounds to as much as half a ton. But for the heavier loads it needs to be especially healthy and fit, the journey must not be too long, the weather not too hot, and there must be frequent water-holes along the route. The purpose in saying this is to draw attention to the fact that there is a tendency to overstate the things a camel can do. Our domestic donkey, which is descended from another desert animal, the wild ass, can do remarkable journeys, carry heavy loads, and generally endure the heat and burden of the day. Nevertheless, some of the journeys made by camels are outstanding, but such journeys are exceptional and, as we shall see, in one case, the results were rather disastrous.

Riding camels, in good condition, have been known to travel ninety-five miles in thirteen hours. In Somaliland some camels made a march of six days without water. Camels that had been taken to Australia as baggage

Camels at an oasis

animals averaged twenty-eight miles a day, loaded, for eight days without water, and in another instance they travelled an average of twenty-three miles a day for seventeen days with no more than one drink. On the other hand, and again it was in northern Australia, camels made a journey of 537 miles in thirty-four days without a drink but most of them died in doing this. A few survived by grazing the dew-wetted herbage on the way.

It is not the intention here to belittle what a camel can do. It can stand up to hard conditions, but so can other desert animals, as well as others that do not live in deserts, when they are driven to it. What we need to do is to see the camel as it really is, and more especially to deal with some of the wrong ideas we often have about it. Its splayed feet, for example, which are said to be ideal for travelling over the desert, often become bruised and torn by sand, whereas the hoofs of horses and asses are unhurt after travelling over the same ground. Often in the desert the ground is rock or gravel and on this the hoof is far superior. Again, camels easily get lost and have to be guided home, whereas a man on horseback, when he is lost, can give the horse his head and know that it will find its way home.

The most frequent legend about the camel, and the one that dies the hardest, is its supposed ability to store water in its stomach, in little pockets in the wall of the stomach. There are many tales of Arabs and other travellers, lost in the desert, being saved from dying of thirst by killing a camel and drinking the liquid in its stomach.

In recent years all this has been studied scientifically and here is what has been found. A camel may drink as

much as twenty-seven gallons of water in ten minutes but only when it is thirsty, and it can go for longer times without drinking, which means it does not so easily suffer from thirst as most animals. If there is plenty of dew-wetted grass or succulent desert plants it may not drink at all.

When we go without drink for a long time our body loses water, and being thirsty merely means that our body is crying out for that lost water to be replaced. A man can only lose water equal to one-sixth of his body-weight before he dies of thirst. A camel can lose water equal to nearly one-third of its body-weight before it is in distress. Meanwhile its body grows thin, and then when it comes to water it will drink from fifteen to twenty-seven gallons, after which the body is back to normal size or perhaps a trifle bloated. But the water is not held in the stomach, which is far too small to hold such large amounts. The liquid in the pockets lining the stomach are digestive juices. These can be drunk, although they taste salty, but to a man dying of thirst even these unpalatable liquids are welcome.

One of the things that makes the camel such a good desert animal is that its body temperature alters during the day. It may be as low as 93° F. in the morning and rise to 104° F. by midday. Our body temperature must remain near 98.6° F. all the time or we suffer for it. At 104° F. a man is in bed with a high fever.

The air temperature in a desert may be 110° F., and any animal in the desert will tend to take in heat. The higher its temperature the less heat it will take in, so the camel at 104° F. is cool by comparison with a man at 98.6° F. At the same time, while the camel's temperature is rising it is storing heat in the body with the result that it does not feel so cold when the cold desert night

falls. It is like a greenhouse that heats up during the day and retains the heat at the end of the day, steadily cooling off during the night.

The camel's hairy body also helps by keeping out the excessive heat during the day and preventing a rapid loss of heat at night. This, and the unusual behaviour of its temperature, together with the fact that a camel can eat the driest thorny vegetation, has long lashes that keep the sand out of its eyes, and nostrils that can be closed to keep the sand out, are the main reasons why it is so much at home in the desert.

The camel we have been considering so far is the one found in Africa and the Middle East, although it has also been taken to Spain, the U.S.A. and Australia, and in all three places has gone wild. It is the Arabian, or one-humped camel, the one that so many people refer to as the dromedary. In fact, a dromedary is a special breed of the Arabian camel that is used only for riding and not for carrying loads. In Asia there is another camel, used for transport of goods. This is the Bactrian, or two-humped camel. Most of what has been said about the Arabian camel here could equally well have been said about the Bactrian camel, except that there are fewer romantic stories about what it can do.

The Bactrian camel is used to cross the deserts of Asia, from Persia across central Asia to the Gobi desert. It is especially used for crossing the dry, cold and inhospitable plateaux, so it is not surprising to find that it has a thicker coat than the Arabian camel.

It has been known for some time that there are camels in the Gobi desert, and it was believed that these were Bactrian camels that had been allowed to go wild. Within the last few years, however, a few photographs

have been taken of the camels in the Gobi desert. These all show camels running away, for it is apparently a very shy member of the family, but from what one can see in the photographs the Gobi desert camel might be a truly wild species, perhaps ancestor to both Bactrian and Arabian camels. The one thing we can be certain of from the photographs is that it has only one hump, whereas if it had been, as was thought, a Bactrian camel gone wild, we should have expected it to have had two humps.

The reason why so little is known about this particular camel is that so little is known about the Gobi desert itself. This desert is nearly 2,000 miles long and about 400 miles across, a barren wilderness of bare rock, loose sand and shingle, with here and there firm patches of sand where there is some scanty vegetation. It is a treeless waste, where the bitter winter lasts for nine months of the year and even the summer is not very enjoyable by our standards. In places, however, there are stretches of grassland that provide pasture for the camels, horses and sheep belonging to the Mongolian nomads, the only human inhabitants of the desert.

Camels are not the only large animals able to live in deserts. The wild ass has already been mentioned, and there are several antelopes in the deserts both of Africa and Asia. In Australia, the large animals in the desert are a few kinds of kangaroo. Before dealing with each of these in turn a few general remarks must be made about large animals in deserts. Where food and water are short even the small animals find it difficult to live. For larger animals the difficulty is going to be even greater. So the question naturally arises why large animals should make their home in deserts at all. The answer is that very few of them belong exclusively to deserts. What we find is that

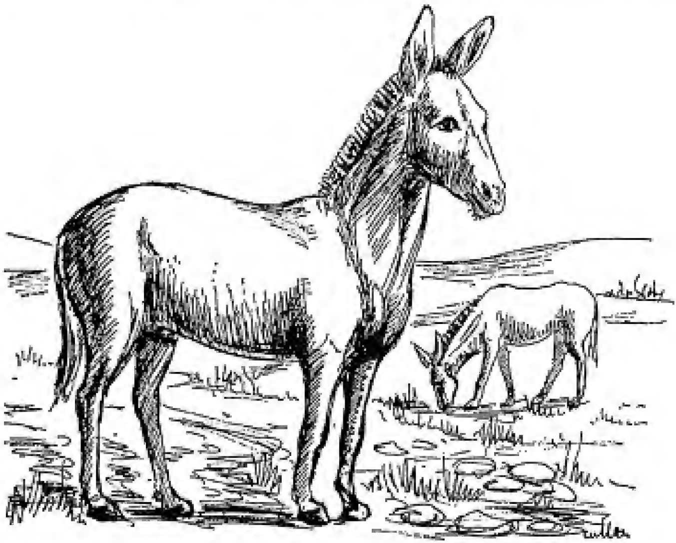
the larger animals are able to live under somewhat dry conditions, and these are found in the semi-dry areas as well as the dry areas. The same species may be found in all kinds of country; where there is plenty of vegetation, where the vegetation is sparse or even where it is so scanty that we may truly speak of desert conditions. This is shown particularly well in the case of the red kangaroo of Australia, which is widely distributed over that continent, in all sorts of situations, and even lives in the deserts. What we do find, and this must always be borne in mind, is that such animals when living in country with plenty of food will live together in large herds. When living in the desert they are more spaced out. Instead of herds of hundreds there will be troops of scores or perhaps only a dozen animals, and where it is very dry they move about in twos or threes.

Another thing that can be said of the large animals in deserts is that men have been more interested in hunting them than in studying how they live. The result is that we know very little about their way of life.

There are several kinds of wild asses living in the more desolate regions of North Africa and of south-west and central Asia, and most of them live in desert regions. Anyone who knows what the domestic donkey looks like will have a fair idea of the appearance of wild asses. They stand three to four feet high at the shoulder, and they have large ears, an erect mane, a tufted tail and a sandy-fawn colour. Asses are related to horses and zebras, and one sign of their family relationship is seen in their markings. They have a dark shoulder stripe and a dark line running down the middle of the back, but what links them most with the zebras, which they resemble in build, is the dark rings so many have on the lower part

of the leg. These markings can often be seen in domestic donkeys also.

There used to be a wild ass in north-west Africa, the Algerian wild ass, but this became extinct in Roman times. Farther east, the Nubian wild ass is today found between the Upper Nile, Ethiopia and the Red Sea. It is



Wild asses are found in North Africa, South-west and Central Asia

still there in fair numbers, but it is hunted by the local tribesmen, who eat its flesh whenever they get the opportunity. The only thing that saves the Nubian wild ass is its wariness, so that it is difficult to get near it on the flat plains where it chooses to live. At one time it was hunted on horseback and on camel, but now that the motor-car is becoming common even in those remote

parts, and is being used to hunt the ass, it is a matter for doubt whether it will survive very much longer. There is another kind of wild ass to the south of this region, in Somaliland.

It is often said that there are wild asses in the Sahara, but it seems much more likely that these are merely the descendants of domesticated asses that have gone wild. The fact that they can live in the Sahara shows how readily asses can stand up to desert conditions. One reason for this is that, like the camel, an ass can, if put to it, go for long periods without drinking, and then, when water is plentiful, take a long drink, as much as fifteen gallons of water at a time. Nobody has ever suggested that an ass stores water in its stomach, yet its capacity for drink is almost as great as that of the camel.

The different Asiatic wild asses are all much alike, but they are given different names in different regions. There used to be wild asses in Syria and Arabia, but these have now been wiped out. From Persia to the deserts of Pakistan the wild ass is known by two names. It is the onager in Persia and the ghorkar in Pakistan. In Transcaspia and Mongolia the same race of ass is known by three different names: the kiang, or kulan, or chigetai. In all these areas the asses lead much the same kind of life, eating such scant vegetation as they can find, moving about in small parties, always alert to danger and ready to dash away. In spite of this, however, heavy inroads have been made into their numbers. Their meat and hides are in demand and with modern firearms being turned on them their natural wariness does not count for much. The new-born foals, although able to run within a few hours after birth, are ridden down by horsemen, caught and sold as domesticated animals.

Gazelles are small antelopes that live more especially in Asia and the drier parts of Africa. A few can be called desert animals, living where only scanty grasses grow. One of these is the Dorcas gazelle. It is one of the smallest and most graceful of the gazelles, less than two feet high at the shoulder, with horns up to thirteen-and-a-half inches long, living from Algeria to Egypt and the Sudan. The slightly-larger Arabian gazelle is found in many parts of Arabia, from Sinai to Aden, and farther east are the goitred gazelle and the Mongolian gazelle. The male goitred gazelle has a curiously inflated throat during the breeding season whence its name, but what purpose this serves is not easy to say. The Mongolian gazelle or zeren is found on the steppes of central Asia, from Tibet to China and eastern Siberia, always on the dry plains and sometimes in places that are true desert. Where the plains are grassy, as in northern Mongolia, it may be in herds numbering thousands, but where there is less food, in desert country, the numbers are less. As with the goitred gazelle, its near relation, the male has an inflated throat in the breeding season.

There is the same story for the small gazelles as for the wild asses: where there is a fair amount of grass the herds may number six hundred or more and when food is short, as in desert regions, they will be only twenty or thirty strong. These small herds are family parties and consist of a male and three or four females, together with their young. Where food is scarce the families keep apart and forage on their own, but they join together to make much larger herds when they do not have to worry where their next meal will come from.

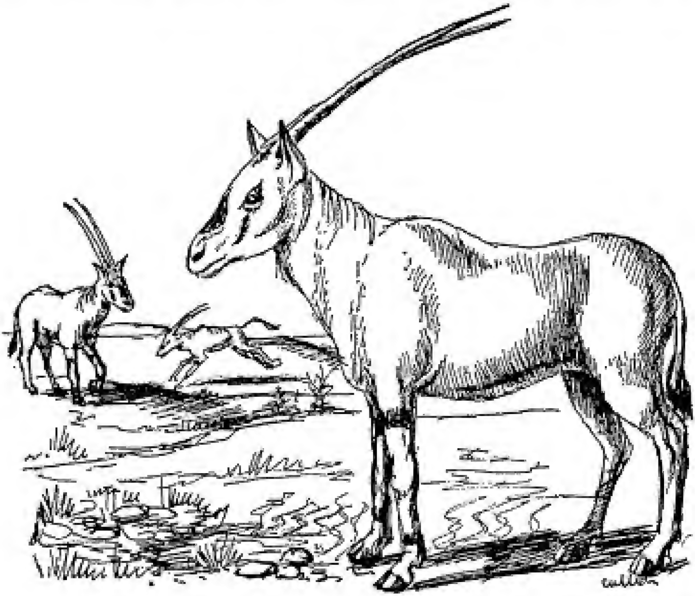
The large desert antelopes are the addax, oryx, and gemsbok. The addax is sandy-coloured, forty-two inches

high at the shoulder, with spirally-twisted horns about three-and-a-half feet long. Its hoofs are short and broad enabling it to travel easily over sand. As with so many desert animals, the addax can travel at speed. This is necessary not so much to escape from natural enemies as to be able to move rapidly from one breeding-ground to another, or to travel long distances for water. Its speed stood it in good stead when men started to hunt it, and at one time it required careful planning to hunt the addax which would lead its pursuers long journeys across waterless plains. With the coming of the motor-car and the modern weapons all this is changed and it is doubtful whether the addax will survive much longer.

We have seen that there is no sharp line to be drawn between deserts and lands that are not desert, and that the same kinds of animals may be found in country that has plenty of vegetation and in desert where there is only scanty vegetation. If then we ask why any animal should choose to live in a desert when it can find a better living elsewhere we find there are two reasons. The first is that they are able to live in deserts where other animals cannot. And the second is that in the deserts they find a refuge, like the bushmen of the Kalahari desert. When the fertile lands are overcrowded those animals that can eke out a living in a desert gradually move over into it. Today the desert is no longer a refuge. The motor-car and automatic weapons have altered all that. We have seen this in the case of the addax. It is even better illustrated by the oryx.

There are several different kinds of oryx. They are all large antelopes, about four feet high at the shoulder, with tufted tails, pale-coloured bodies and black markings on the face and also on the throat, belly and legs. The one

thing by which they can be readily recognized is their long horns, straight and marked with rings. These horns spring from the forehead just above the eyes and when the animal is looked at from a particular angle it appears to have one horn only because the nearest horn then



The Beisa Oryx of East Africa

masks the one farthest from the observer. The East African oryx, which lives on parts of the coast of the Red Sea, as well as in Ethiopia and Somaliland, is believed to have been the original of the unicorn legend, because looked at from a certain angle it seems to have one horn springing from the middle of its forehead. The East African oryx may be found on stony semi-deserts and also

on the grassy plains and in almost any country but the dense forests. It is hunted with packs of yellow pariah dogs, but the long, sabre-like horns can be used with deadly effect against the dogs. There have even been stories of lions found transfixed on the horns of the oryx.

Farther west, in the true deserts of the Sudan, lives the white or scimitar oryx, the first name referring to the colour and the second to the shape of its horns. The white oryx is very pale in colour and has little of the dark markings found in the other oryxes. Its horns may be as much as forty-five inches long. This oryx is a nomad, moving about the desert in search of pasture according to the rainy seasons.

Across the Red Sea, in the deserts of Arabia, is the Arabian or Beatrix oryx, almost white over most of the body and with chocolate markings on the legs. It used to be common also in Syria and Iraq, but has now been driven into the Arabian deserts where it has survived until now, largely because men found difficulty in travelling across the desert. It has suffered largely because it was traditional among the Arabs that for a man to have killed an oryx was the hallmark of a skilful hunter. Until a few years ago, the hunter had to stalk the oryx, a very shy animal, across the parched sandy plains, and even when he had closed in on his quarry he needed to be a good marksman to get it. So, when an Arab hunter had made a kill he wrapped a piece of the oryx hide round the butt of his rifle to show his prowess. Times have changed. The finding of oil in the deserts of the Middle East has brought to the Arab princes and chiefs a wealth they had seldom known before. They can afford fleets of fast cars and modern weapons, and the present method of hunting is to sally forth across the desert in several

hundred cars strung out on a broad front, armed with quick-firing automatics, shooting up anything that moves. One victim of these organized hunts is the Arabian oryx, and today only a few survive in the more inaccessible parts of the desert.

The last kind of oryx, known as the gemsbok, lives in South-West Africa, in the semi-deserts mainly, but also including the well-known Kalahari desert. There its ability to live in waterless regions has saved it, and added to this there has been specially set aside in the Kalahari a Gemsbok National Park to preserve this most handsome fawn-grey antelope with the black face markings.

The gemsbok obtains much of its moisture from a wild melon, the tsama, growing in the dry surroundings. The other oryxes also obtain moisture from succulents for they seldom come across running water. One naturalist trailed an Arabian oryx for several weeks during which time he never once saw it drink. Moreover, on an island in the Red Sea there was a small herd of oryxes, and there was not a drop of standing or running water on the island, yet the oryxes were in perfect condition.

Chapter Four

SMALL DESERT ANIMALS

The large desert animals we have dealt with so far all belong to the kind known as mammals. They are the animals whose bodies are covered with hair, whose young are born alive and suckled by the mothers in the early stages of their lives. In this chapter we shall be dealing with the small and medium-sized mammals. Because these are smaller and therefore easier to handle, and because they do not move about over such great distances, much more study has been made of them. As a result, we know much more about why they are able to live in deserts, how they are able to cope with the heat and how they are able to manage without water. There are other things we know about them, which shed light generally on the problem of living under the very rigorous conditions found in deserts.

Over a large part of the North African part of the Sahara desert, a French zoologist made a survey of all the mammals living there. He found there were fifty-eight different kinds. Of these only twenty-four were true desert species. Stress has already been laid on the fact that, for all deserts wherever they are found, some of the animals living in them are also found in the surrounding country where conditions are not so dry, where indeed there may be abundant green food. Here, however, as a

result of this survey, we can see this same idea expressed in numbers: that less than half of the mammals found in deserts are true desert animals, that is, are adapted specially for living in intense heat and with very little water. In that part of the Sahara they included two kinds of hedgehogs, two flesh-eaters (carnivores), seventeen rodents and one hare, together with two antelopes.

There are not many more kinds of wild mammals in the British Isles, although all the land is fertile and there is abundant food, but their numbers are high. This is where the desert mammals differ: they are widely spaced out on the ground. This was shown by another French zoologist who made a count, in an area of desert a mile square, of the numbers of one kind of desert rat. He found there were only thirteen living in this large area. This is about one desert rat to the equivalent of a ten-acre field.

Since the small or medium-sized mammals living in deserts have unfamiliar names it may be as well to make the acquaintance of these names and of the animals bearing them. The hedgehogs will be easy, because we are all familiar with this kind of animal. There is not a great deal of difference between our native hedgehog and those found in the desert. Both lie up during the day and both come out at night to feed. We are not sure what the desert hedgehog feeds on, but it is probably much the same as the food of the common hedgehog, insects and snails, any small animals it can catch, and perhaps some vegetation, because even the common hedgehog will eat fruit, although many people think they take only small animal food.

In the Sahara the two carnivores are the bat-eared fox and the fennec fox. Both of these, like the hedgehogs, lie up in burrows during the day and come out at night

to feed. This is something of a rule for the small desert animals, but before getting on to that rule let us see what else we shall find there. In the Sahara there will be jerboas and gerbils, as well as sand rats; and believe it or not there is at least one bat. So there must be insects, for the bat to feed on, and therefore, there must be insects for the hedgehogs. And again, believe it not, there are desert snails—and there is at least one amusing story to be told about them later on.

The sand rats, or jirds, are very like the black and brown rats we have here except in their colour, which is sandy-grey, and they feed mainly on seeds. Another thing about them is that the desire to live well spaced out is very deeply ingrained, with the result that if they find themselves crowded together they are apt to fight, doing each other serious injury, often with fatal results. It is as if some instinct tells them that there will not be enough food for a crowd, so they set about making sure that there shall only be a very few of them.

The jirds and the gerbils make up a sub-family which is confined to the drier parts of Africa and Asia. The gerbils are more mouse-like, sandy in colour, and not to be confused with the jerboas, which we shall talk about in a moment. But although we speak of them as mouse-like, and the jirds as sand rats, they have hairy tails, and the ends of the tails are often tufted and the hind feet are longer. In the gerbils, also, the hind legs are noticeably long so that these small rodents are more like miniature kangaroos hopping across the sand. Their underparts and feet are white, their eyes and ears are large. They live in burrows during the day and come out at night to feed on seeds. They have the same habit as rats and mice of storing food, and this stands them in good stead in the

desert, where, as we have seen, following one of the infrequent rainstorms, the flowers spring up and cast their seeds in a short time. The gerbils must harvest these and store them against the periods of scarcity.

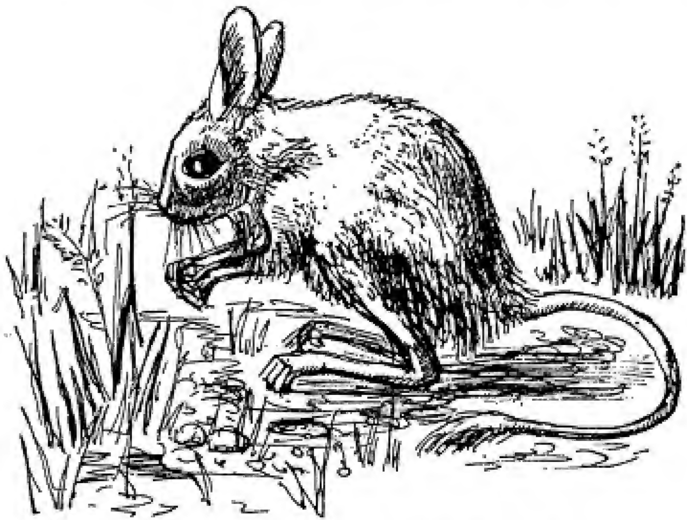
There is one particular gerbil of the Sahara that deserves special mention. This is the fat-tailed gerbil. It has a short club-shaped tail. Instead of storing food in its burrow it eats all it can, when there is plenty, and stores up fat in its tail. This gerbil is very difficult to find because it is so widely spaced out. The same French zoologist who counted the number of desert rats in a square mile had to search for six months before he found a fat-tailed gerbil.

Although the jerboas belong to a different family, they have the kangaroo-like build of the gerbils. There are a number of different kinds, all found in the sandy deserts or stony plains of North Africa, Arabia, and through central Asia to Mongolia. The hind foot of a jerboa has only three toes, and the long bones of the foot, the metatarsals, as they are called, are fused together to form a single cannon bone. This peculiar structure of the bones of the foot gives them power and speed in jumping. The jerboa's tail is long and powerful, and is used as a third leg to support the body when the jerboa is standing up, like the tail of a kangaroo. It has a black-and-white feathered tuft at the end.

Although the jerboa looks like a rat, and is related if distantly to rats, it is a rat with a difference. Its sandy-coloured body, white front, large eyes and extremely large ears, make it a most attractive animal to look at, and it moves about in an upright position, with the weak fore-limbs taking little part in walking or jumping. It spends the day in its underground burrow, to avoid the heat, and

comes out at night to feed on seeds and any vegetable matter it can find. And it seems to be able to go without drinking.

The best known is the Egyptian jerboa, but the long-eared jerboa of the Mongolian deserts, a very rare animal, has most extraordinary ears, half as long as the head and



Jerboas are found in North Africa and Asia

body put together. In fact, it has the largest ears, in proportion to its size, of any known animal.

We have to say "of any known animal" because we never know when another one with larger ears may be discovered. Within the last twenty years three jerboas that had not been previously seen were discovered. They were all dwarf jerboas, but in these instances they all had small ears. Each of these new jerboas is as small as a

mouse but more delicately built, with enormous whiskers and thick tufts of stiff hairs on the hind feet, making them almost like snow-shoes except that they are used for travelling easily over the sand instead of over powdery snow. One of these new jerboas has a long tail, feathered with hairs scattered along each side of it, but it is the length that is so remarkable for it is two-and-a-quarter times the total length of the animal's body and head combined. The other two kinds of newly-discovered jerboas have short tails, but in each of these the tail is swollen at the base where it is filled with a store of fat.

We said in an earlier chapter that the plants and animals looked much alike no matter in which part of the world the desert was found. Nowhere is this more strikingly shown than in the small rodents. We have seen how the gerbils and jerboas are like miniature kangaroos, and how they are found in the deserts of North Africa and Asia. If we go over to the deserts of south-west U.S.A. we find a small rodent that is actually called the kangaroo-rat. Then, if we hop across the world to Australia there we find the rat-kangaroo, but not in the deserts, and it is mentioned here because the similarity of these two names is apt to be confusing, and in case you come across either of these names it is as well to know what they mean. The rat-kangaroo is one of the smallest of the kangaroos, no bigger than a rat. The kangaroo-rat is a rat that looks like a small kangaroo. In the Australian desert, moreover, there is a marsupial jerboa, and there are also jumping mice.

This is, perhaps, a convenient place to say a word or two about why so many of the rodents found in the various deserts the world over have this kangaroo shape. As we saw, when dealing with the large desert animals, the

antelopes and the kangaroos, as well as the camel and the ass, all are built for speed. That is, they are built for getting quickly from one place to another, for covering a large area of ground in as short a time as possible. There are three reasons why this should be necessary.

Because desert animals have to find a scanty living in

Kangaroo-rat from the south-western deserts of America

some of the most inhospitable parts of the earth they have to forage over a wide area to find enough food. This means that they cannot afford to go slowly or they would face starvation. Secondly, because water is so rare they may have to make long journeys to find it, or to find the plants that store water in their tissues, like the cacti and the succulents. Again, they cannot afford to go slowly

when they may have to search a wide area and get back to their burrows before the sun rises and starts to heat the sand. Thirdly, animals that are so widely scattered will have to travel long distances to find a mate in the breeding season. Again, they cannot afford to linger over such journeys.

In the second of these reasons we have mentioned the need for the small desert rodents to get back to their burrows before the rising sun begins to warm up the sand. A small animal is at a disadvantage compared to a large desert animal because temperatures by day are always higher at ground level, at the actual surface of the ground. That is why, practically without exception, the small mammals spend the day in burrows, for where the sand may be so hot as to hardly bear touching, at a depth of no more than six inches from the surface the temperature is not only low but remains low no matter how much the sand above heats up. Another advantage of spending the day six inches below the surface is that at that depth the amount of moisture in the air—the humidity of the air, as it is called—remains much the same all the time.

When living in the desert one of the chief problems is water. The animals must not only take water into the body but they must also be able to prevent undue loss of water from the body. To prevent something drying up you put it into a moist atmosphere. To prevent undue loss of water from the body the small mammals remain underground during the hottest part of the day in burrows where the humidity, or the amount of moisture in the air, remains the same at all times. There are other ways of preventing loss of water from the body, and we shall have more to say about this when we come to deal with the kangaroo-rat of the North American deserts. In the

meantime we had better make the closer acquaintance of some of the small mammals in the deserts outside North Africa and Asia.

The mammals of Australia, as is well known, are different to those found elsewhere in the world. Except for the two egg-laying mammals, the platypus and echidna, a few native rats and the bats, all the Australian mammals are pouch-bearers, or marsupials. That is, the females have a pouch formed by a fold of skin on the abdomen and the young, which are born at a very early stage in development, make their way to this pouch and there remain until they are able to look after themselves. Although there is this striking difference between the marsupials and the mammals in other parts of the world the true desert animals of Australia are very like those found elsewhere. They are the marsupial jerboa and the jumping mouse. To make things even more difficult to follow there are also in the deserts of central Australia jerboa rats, as well as marsupial mice and of all things a marsupial mole.

To make these things clearer a few words of explanation are needed. When two straight lines start from points far apart and then slowly draw together, like a pair of railway lines seen running into the distance, we say they are converging. When two animals belonging to completely different families look almost exactly alike, we say they are convergent; and we speak of the series of changes by which they have come to look alike as convergent evolution. This merely means that animals that live under the same conditions tend to look alike. That is to say, although their ancestors may have been markedly different from each other their descendants have grown to look alike, or they have followed a convergent evolution.

This is an idea not easy to understand, but we have a very striking illustration of it in the small desert animals. For example, in the Sahara there are jerboas, rodents with long hind legs and weak forelegs, that leap about over the sand. In the deserts of the south-west U.S.A. there are kangaroo-rats with long hind legs and short front legs that leap about over the sand. Yet the two are not very closely related. In Australia, there are marsupials, which are totally unrelated to either the jerboas or the kangaroo-rats, that have long hind legs and short front legs and they too leap about over the sands of the desert. What is more, in Australia, where there are only a few native species of true rats there are, nevertheless, some which, living in the deserts, have come to have long hind legs and short front legs and leap about over the sand.

Let us hope you have been able to understand that, which is after all a quite difficult idea to grasp. And if you have then we can proceed with the story of the small mammals of the Australian deserts.

The marsupial jerboas are so very like the true jerboas of Africa except that the females carry their young in a pouch that there is no need to describe what they look like, except to say that their legs and toes are like those of kangaroos and therefore very unlike those of the legs and toes of true rats and mice. They are very rare animals, as we have seen is so often the case with small desert animals. In fact, their existence was unknown until 1865, when they were first found by the great Australian naturalist, Gould. And then nothing more was seen of them for a long time, and everybody thought they must be extinct until a schoolgirl living in New South Wales rediscovered them in 1943. Singularly enough, the

marsupial jerboas live in the same burrows as kangaroo-mice which are true rodents that also have the long legs and the general appearance of jerboas. These are also called jumping mice.

The marsupial mice—not to be confused with the jumping or kangaroo-mice, may be the size of a mouse to the size of a rat. The various kinds are found over most of Australia, but there is at least one that is found in the deserts of central Australia. This is the crest-tailed marsupial mouse, a practised killer of small mammals and birds. After killing a rat or a mouse, it has the habit of eating its victim from head to tail, turning back the skin as it goes along and finally leaving the empty skin inside out. It also has the habit, not often met with in small mammals living in the desert, of lying flat to bask in the sun.

Australia is, as we have seen, the land of the marsupials with only a few of the mammals seen elsewhere in the world, notably a few species of rats and some bats. But although the rats are few in number they are remarkable in many ways. Two of the most remarkable are the jerbos rats with long hind legs and a long tail, with a tuft of hair at the tip, looking exactly like one of the true jerboas, and the stick-nest rats. The second of these build large nests of sticks on the ground in the Central Desert, using a thorn bush as a foundation. Inside the nest are several chambers. Several rats will work together to build the nest and they share the chambers inside. Most remarkable of all, when the high winds blow the rats put stones on top of the nest to hold the materials in place.

Finally, out of all the small desert mammals with the long legs and long tails, we come to the kangaroo-rat of the deserts of the south-western U.S.A. This belongs to

an entirely different family to all the others we have been talking about and yet it also is remarkably like a jerboa. It is about a foot long, with short forelegs, used only for holding food, very long hind legs, used for moving about in leaps up to six feet at a time, and a long tail tufted at the end used as a balancing organ. Its eyes and ears are large. Its fur is soft and long, and its hind feet and toes are covered with fur underneath the better to grip the loose dry sand. Its colour is a cinnamon-buff or sandy-fawn, with pure white underparts and a white stripe on the thighs. The tail is black above, white below, and the end tuft is black-and-white. Kangaroo-rats live in the warmer drier regions burrowing in loose sand and coming out only at night to search for seeds: and one thing they have, which the other jumping desert mammals we have been considering lack, is cheek-pouches in which to store seeds. Anyone who has kept hamsters will be familiar with these cheek-pouches and will have seen how a hamster stuffs the pouches with surplus food and then empties them when it is inside its nest.

Kangaroo-rats are sometimes called pocket rats because of these cheek-pouches, and also because their nearest relatives are the pocket-gophers. Another of the small desert mammals belonging to the same family as the kangaroo-rats are the pocket-mice. These may be anything from five to nine inches long, and they also are shaped like jerboas, and they too live on the desert plains of the western U.S.A. Pocket-mice also come out at night to search for seeds. They spend the daytime in burrows and they plug the entrance of these with sand to keep out the heat. This may possibly serve also to keep out the snakes.

Kangaroo-rats and pocket-mice are said to be able to

live indefinitely without drinking, and in the last twenty years particular study has been made of this by two American zoologists. Before dealing with the results of these studies let us take a closer look at how this water problem affects animals generally. No animal can do without water, and there are three ways in which they can obtain it. The first way, and the one we are most familiar with, is by drinking it. The second is to obtain it from food that contains a lot of water. The third way is to obtain it from what is known as physiological water. Even dry food can be broken down by the chemistry of the body to set free oxygen and hydrogen molecules which then combine to form water (two hydrogen molecules and one oxygen molecule combine to give H_2O, the chemical formula for water).

The water in the body of an animal depends, naturally, on the kind of animal we are dealing with. For mammals it varies from 63 per cent of the total weight of the animal in an ant-eater to 87 per cent in a camel and 90 per cent in a donkey. On the whole, therefore, it seems to be more in desert animals than in others. This may be because their bodies are geared to holding as much water as possible. Most of the water in the body is in the blood, which contains anything from 91 to 94 per cent of water, and in the other body fluids, such as the lymph.

Water can be lost from the body in any one of four ways: in the urine, in the excreta, in the breath and through the sweat glands. In human sweat, for example, there is 98 per cent water, and while it is not easy to give figures for the amount of water we lose in breathing out we know our breath is moist because if we want to moisten something very slightly we breathe on it.

The kangaroo-rat has been found, under careful experimental tests, to be able to go without drinking altogether, even although it eats only dry seeds. What this means can be judged from this simple equation: an apple is 87 per cent water and dry seeds, such as the small seeds of flowering plants, have as little as 2 per cent water while large seeds like wheat grains have at most only 13 per cent. So the kangaroo-rat, and probably this is true for other small desert mammals, conserves water in the following ways: it does not sweat, its excreta are solid, and almost dry, its urine is almost solid, and when it breathes out the moisture in the outgoing breath is condensed in the cavity of the nostrils and passes back into the body to be used again.

Another way to conserve the water of the body would be to live all the time underground. We have already seen that at a depth of six inches there is a constant temperature and humidity, and where, as at this depth, the air retains its moisture so the body of an animal living underground would lose much less water. All over the world there are moles living permanently underground, but they live mainly in damp situations and their food is largely earthworms. Although there are no moles in the deserts there are several animals that look like them. In the deserts of central Asia there are rodents known as mole-lemmings, or mole-voles. Their bodies are mouse-like but more rounded. The nose is blunt, there is no neck, the eyes and ears are small, the tail very short and the legs are very short and armed with claws for digging. They look, in fact, like mice that are half-way to becoming moles.

The Australian marsupial mole has gone even further. Although not related at all to the true moles it looks

almost exactly like one, except that it has a horny shield on the snout and two, instead of five, stout claws on the forefeet. Its silky fur also is a golden colour. In addition, of course, the female carries her young in a pouch.

There is not the space to deal with all the small mammals found in deserts and we have had to pick out those which best illustrate life in the deserts. One thing that is becoming more and more striking as we examine one animal after another, is that the colour of desert animals is so often sandy or some shade of colour near to it. This, it used to be thought, was protective, a colour that made its wearers inconspicuous against a background of sand and therefore concealed them from their enemies. When we recall, however, that so many of the small mammals spend the daylight hours underground and only come out at night the matter begins to take on a different complexion. And then there are the bats. They fly only at night, spending the days in clefts in the rocks or in caves. Yet their fur is also a light colour. There is one bat, Kuhl's pipistrelle, which is found from southern Europe to the Sahara. In southern Europe it is almost black. In the hilly country of Algeria it is green and in the Sahara it is yellow to whitish-grey. What the meaning of this generally sandy colour of desert animals may be is not known, and although it may serve in some animals as a camouflage the real reason for it may be a matter of temperature, or some other such cause.

So far, we have dealt only with those animals that eat seeds, vegetation, insects and such things. They are the vegetarians and the general feeders. In any community of animals there must be those that eat flesh, that prey upon the vegetable and insect feeders, to keep their numbers in check. The deserts are no exception to the

rule. In all deserts there are snakes, but these feed only on the smaller mammals. There is still room for the larger animals of prey. Where the deserts are not extensive, as in North America, the same beasts of prey will be found in the desert as in the surrounding country. In that case it is the puma or mountain lion. In the vast central deserts of Australia the carnivores are desert

The large-eared Fennec Fox

varieties of those found in the more fertile country, such as the native cat, that is found over nearly the whole of Australia.

There are, however, in the Sahara, desert foxes and these are remarkable for one thing more especially. That is the size of their ears. There are sand foxes in the semi-deserts of North Africa and Arabia, but the fennec is found only in the true deserts in these regions. The fennec

has a total length of two feet, but it has enormous ears, about six inches long. The soles of its feet are hairy, enabling it to run on loose sand, and its colour is a pale sandy buff. Like so many of the desert animals it avoids the heat of the day by staying underground, and it comes out at night to feed on insects, especially locusts when these are about, and the small mammals.

Large ears tend to be the rule in so many small desert mammals. One reason for this is that large ears offer a large surface for the loss of body heat. In other words, they tend to keep the body cool. At the same time, the inner ear, the real mechanism for hearing, is also large, so that the hearing of the fennec and other desert animals with large ears is very acute. This is believed to be necessary because all animals are spaced well apart in the deserts, and particularly good hearing is necessary not only for hunting, and for the detection of enemies, but also for finding a mate.

Chapter Five

BIRDS AND REPTILES

THERE are very few truly desert birds. There are birds that go into desert regions and that are of the same species as those living at the edge of the desert or even where vegetation is lush. If, for example, a wild ass or an oryx dies and its carcass lies in the desert the bones will soon be picked clean. Vultures can fly enormous distances and they can see a carcass on the ground when they are out of our sight up in the heavens, and miles away whichever way we measure. Other birds, especially birds of prey, can find a living especially on the margins of the desert, and can nest and bring off their young provided they can find a place among rocks which is shaded from the blazeing heat at midday. The elf owl, of Mexico and the south-western U.S.A., one of the smallest of the owls, lives in open woodlands and among large cacti, often nesting in the giant saguaro cactus. It lives on insects caught on the wing. But although it lives among cacti it is not a desert bird in the strict sense of the term.

The California quail ranges over the bushy grasslands and semi-deserts of Mexico and the south-western U.S.A. but it has the characteristics we should expect to find in a true desert bird. For example, when it is living in semi-desert, where succulent vegetation is growing it can go for months or even years without drinking, getting its water, along with its food, from the succulents.

Attention will be given in this chapter, therefore, to the ostrich, sand grouse and a few of the smaller birds that strictly belong to deserts. Perhaps we never think of the ostrich as a desert bird, and yet we ought to do so. One reason, perhaps, why we fail to do so is because most of the ostriches living today are in ostrich farms in South Africa. So when we see photographs of them, these show as a rule trees and farm-buildings in the background. The reason why we ought to think of them as truly desert birds is because we so often hear people talking about ostriches sticking their heads in the sand.

Let us take this last point, which is so obviously wrong. If an ostrich did push its head into the sand as soon as danger threatened it would put itself into even greater danger. It would be unable to breathe, and would soon be suffocated.

There is little need to say what an ostrich looks like. We are all too familiar with its picture. What we can do is to draw attention to some of its features which fit it for life on the dry sandy plains. Above all, it is a bird that cannot fly but it has very long legs and can run fast, and this, as we have seen, is a feature of all the large desert animals. Then, if we take a close look at that extraordinarily small head on its long neck, we see that the eyelids have lashes, made up of a fringe of hair-like feathers. In fact, the eyes of an ostrich look very like the eyes of a camel.

As is usual in birds, an ostrich has no external ear, but at the back of the head on each side is a deep pit leading to the ear-drum. These, we might suppose, would be wonderful receptacles to become filled with sand as soon as the desert winds begin to blow, until we look more carefully. Then we find that the ostrich can close its ears,

and, indeed, even when living in a zoo far away from blown sand, is constantly closing and opening its ears.

There are so many common beliefs about ostriches that are wrong that it is difficult to say how they live without having to turn aside to give the truth about them. For example, it is often said that ostriches lay their eggs in the sand and leave them there for the sun to hatch. Temperature readings taken with a thermometer show that if the hen ostrich did this the eggs would be partially cooked by the burning rays. Even if she covered them with a layer of sand, as is sometimes said, the result would not be very different.

The truth is that ostrich eggs are incubated continuously. During the day, from 9 a.m. until 4 p.m. the hen sits on the eggs. Her feathers are brownish so that as she sits on the nest, which is no more than a saucer scooped out of the sand by the cock ostrich, she harmonizes with the scenery. In fact, she looks very much like one of the brown, dry thorn-bushes scattered over the landscape.

At four o'clock in the afternoon the cock ostrich relieves the hen at the nest. His feathers are black except for the white plumes in the wings and tail, and it is believed that this is the best colour for remaining unseen at night. Whether this is so or not is a matter of guesswork. Already so much that is said about ostriches has been shown to be untrue that one is almost afraid to say anything at all about these large, familiar birds. Indeed, the truest thing we can say about them is that we know very little about them. It is very difficult indeed to find out anything about how much they drink, and when, or whether, like other desert animals they can go for long periods without drinking. We know little about what they eat in the

wild, but as ostriches have been seen to swallow the most unlikely things, we can suppose that the same holds good for their food, and that they will eat almost anything. They are said to eat grass, leaves, fruit, berries, seeds, insects, lizards, snakes, birds, and small mammals, and although this wide diet sheet has been largely compiled from watching captive ostriches, it is probable that it holds true for wild ostriches.

We know a little more about the sand grouse. There are several different kinds of sand grouse and all live in dry situations where there is only sand and short grass. They are related to pigeons, and these and sand grouse are the only birds that drink with the bill held all the time in the water, instead of lifting the head to let the water run down the throat.

During the day the sand grouse feed on seeds and any fresh green shoots they can find. They fly about very little, and when not feeding they scrape shallow depressions in the ground, lie down and dust-bathe, rather in the way that domestic fowl will do. And they seem not to mind the heat. This is because their feathers are set close together, and are covered with a down, which together keep the direct heat of the sun's rays out, as well as the reflected heat from the burning sand, and because their legs and sometimes the toes have feathers they can walk fairly easily over the sand. In fact, the toes of some sand grouse are slightly webbed.

Regularly at dusk and in the early morning, the sand grouse, which live in flocks, fly off to distant watering holes. They are plump-bodied birds, coloured various shades of brown, with only a few distinct markings. Their legs are very short. On arriving at the water-hole they wade in, until their underfeathers are in the water, and

then they drink their fill, after which they go back whence they came.

Although the adult sand grouse can fly long distances to water, they nest in the dry regions and the question has always been, how do the nestlings get their water. The usual explanation has been that the parents come back from the water-hole with the feathers of the abdomen wet, and that the nestlings drink the water from these feathers. This we now know is not the case. What really happens is that the parents come back with their crops filled with water, and by allowing this to come back into their beaks they enable the nestlings to take the water from their beaks.

Sand grouse nest in the sand, much as ostriches do, scraping a saucer in the sand, but they do put a few scraps of grass in this, in a feeble representation of a nest. But they only lay two to three eggs, the shells of which are spotted and mottled with browns and purples. Like the ostrich, the hen sits on the nest by day and the cock sits at night, the reverse to what happens in pigeons, their nearest relatives. This means that while the eggs are being incubated only one parent can go to drink, and what happens is that the cock goes to the water-hole and brings water back in his crop for the hen.

In the Kalahari desert are several sand larks, living in flocks, but not much is known about their habits. A near relative of theirs, living in the deserts of north-east Africa, has a long, curved bill like a hoopoe and is called the hoopoe lark. It uses its bill to probe the sand for grubs of the desert locust.

The next groups of animals we have to deal with are the reptiles. Those living in the deserts are mainly lizards and snakes. For them the problems are, naturally, much

the same as for other animals. Because they are smaller there are, however, some additional problems. We can sum up all these roughly in this way. To escape the great heat at midday, and the intense cold at night, the lizards and snakes do very much the same as the small rodents, such as desert rats. They burrow into the sand, either making their own burrows or using those made by rodents, or else, where there is rocky ground, they go into the crevices between the rocks.

One thing especially to be noted is that lizards burrowing into sand usually have flaps or fringes on the sides of their toes. These make the foot more shovel-like. They are also useful for giving a broad surface to the feet for running over loose sand.

When rats and other small furred animals dig in the sand they follow the usual practice of so many burrowers of loosening the sand with the front feet, passing it back to the hind feet which kick it farther away. Although they do this neatly and efficiently grains of sand are apt to fly about where they are not wanted, and a grain in the eye can be very troublesome, as we all know. But the furred animals, like us, have eyelids to protect the eyes, and these are fringed with eyelashes to give even more protection against flying particles.

One of the chief differences between lizards and snakes taken as a whole is that lizards have movable eyelids while snakes have no movable eyelids. Lizards and snakes living in the deserts need something more than this. We shall be considering some of the different ways in which their eyes are protected from sand when we come to deal with the individual species. We can say now, however, that there are mainly two ways in which this is done. The first is by hoods of skin over the eyes, to which sometimes are

added fringes of scales along the edges of the lids making in effect eyelashes. Others have transparent shields, which can best be described as spectacles, over the eye.

The small furred animals, as we have seen, have large external ears. Sand is kept out of these by the hairs lining the inside of the ear-flap. Snakes do not hear in the usual way. That is, they have no ear-drum, and the bone that, in other reptiles, transmits vibrations from the ear-drum to the inner ear, the real organ of hearing, rests with its outer end against the bone which supports the lower jaw. It is possible, therefore, although of course we cannot be sure, that a snake hears by vibrations carried through the ground, and then through the snake's own body. The old business of the snake charmer playing on his pipe to make the snake dance is just showmanship. The snake cannot hear the airborne sounds, and is merely swaying as the snake charmer himself sways from side-to-side. At all events, snakes have no ear-drums to be injured by sand-grains, and in desert lizards the ear-drum, which in other lizards can be seen lying flush with the side of the head, has a covering of protective scales.

The protection of the eyes and the ear-drums is very important to desert-living reptiles because so many of them bury themselves in the sand, quite apart from their burrowing, and many of them make their way about by what has been called "swimming" in the sand.

It has already been said, and this cannot be too strongly emphasised, that animals living in deserts show many similarities, whether their homes are in the deserts of Africa, Australia or North America. So with reptiles, as with other animals, we shall illustrate what we have to say by describing one reptile after another irrespective of which part of the world they inhabit.

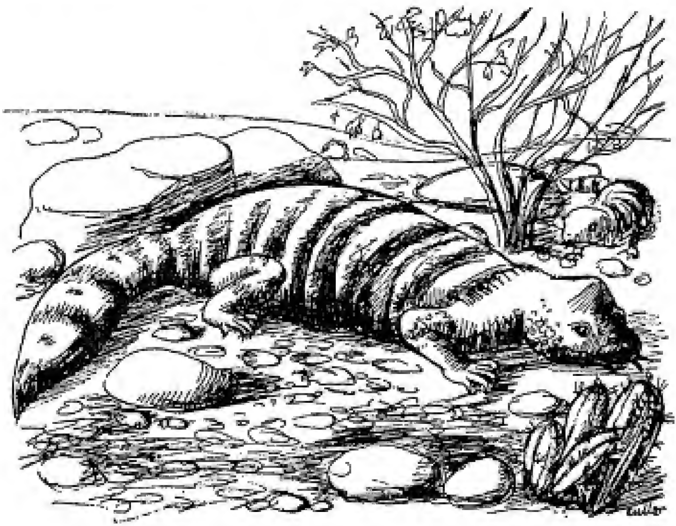
First, then, we will take the lizards. And it will be appropriate to take first the poisonous lizards. Of all the 2,500 or more different kinds of lizards living in various parts of the world, only two are poisonous. One is known as the Gila (pronounced *heela*) monster and the other is called the beaded lizard. They both look alike and both are closely related. Moreover, both live in the deserts of the south-western U.S.A. and the deserts in adjacent parts of Mexico. The Gila monster is only twenty inches long and is mainly pink and yellow, with some black, the beaded lizard is up to thirty-two inches long and is mainly black with pink and yellow patches. Both these lizards move about very slowly. They also spend long periods in their burrows, coming out only at the rainy seasons, and even then mainly at night. Being so slow in movement they must eat things that cannot run away, such as eggs, nestlings and baby rodents. These they track down by smell and by tasting the sand for scent particles from the birds' nests or from the rodents' burrows.

Nesting time occupies only a short period each year, and if there is no rainfall at all for that year, as can often happen, the birds may not nest at all and the rodents may have no youngsters. The Gila monster and the beaded lizard must therefore be able to go for long periods without eating. When there is food they eat all they can find and store the surplus as fat in the body, especially in the tail. One Gila monster caught in the Arizona desert, after three years of drought, was little more than skin and bone, yet it soon recovered on being fed and in six months had doubled in size.

All reptiles, no matter where they are living, seem to be able to go for long periods without food, some more so than others. This ability to fast is particularly marked in those

living in deserts. Most lizards feed on insects, and in the deserts these may not always be easy to find. There is one that lives on vegetation, and this may be in even more short supply.

The vegetarian lizard is the spiny-tailed agama. This lives in the deserts and semi-deserts of North Africa and



The Gila Monster, one of the poisonous lizards

western Asia. Most agamas have slender tails. This one has a spiny tail, which takes up slightly less than half its total length of about a foot. The tail is covered with large pointed scales arranged in rings, a formidable weapon to look at, yet the spiny-tailed agama is inoffensive and only uses the tail in defence. Its food is grass, leaves, flowers and fruit. In fact, any vegetation it can find. But these things may not always be there. This does not bother the agama

which retires to its burrow and goes without, perhaps for a month or more at a time.

Its burrow is quite a large affair, eight or nine feet long and as much as five feet down into the sand. What is more remarkable, instead of having the aids to digging that so many lizards have, namely fringes on the toes, this agama has only its strong claws with which to dig. The burrow not only serves as a refuge against sharp changes from heat to cold, but also serves as a fortress against enemies. In moments of danger, the agama runs into its burrow, turns and puts its tail out through the entrance. Then, if anything tries to attack, it whips the tail, armed with the rings of heavy spines, from side to side.

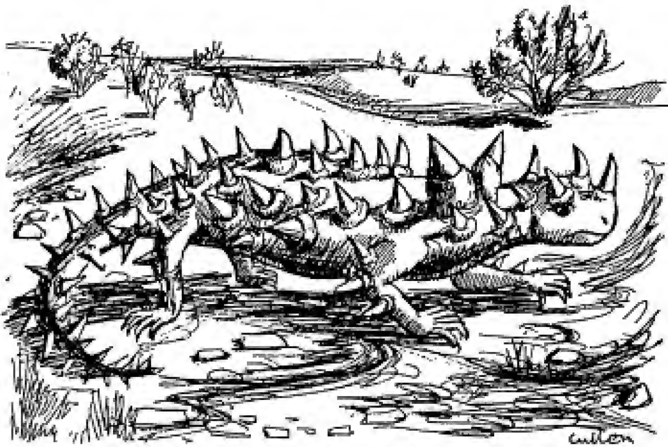
Should it hear an enemy approaching the burrow while it is inside it runs to the entrance and blocks it with its tail at the ready. People living in the deserts in southern Asia take advantage of this. They brush the ground with a few thorny branches to make the sound of a snake rustling, the agama puts its tail out and they seize it. Skinned, this tail is regarded as a delicacy.

In Egypt, travelling showmen carry with them one of these spiny-tailed agamas. They exhibit it to spectators who, seeing this wicked-looking tail lashing, think the showman very brave because he dares to handle the agama, not knowing, as he does, that the animal is quite harmless.

Some of the desert reptiles have spines all over the body. One of the best known is the moloch or thorny-devil of the Australian desert. This is about eight inches long, coloured orange and brown. Its body, head, limbs and tail are covered with low mounds from each of which springs a large spine shaped like one of the thorns on a rose tree. The moloch is slow and deliberate in its movements, and

for a good reason: it does not need to run after its food. It lies in wait for ants, consuming a thousand or more at each meal.

Across the world from where the moloch lives, in the deserts of North America, is another lizard, the horned toad, that looks very like it. And here we have, once again,



The Moloch or Thorny-devil

this convergence, such as we had in the jerboas, rat-kangaroos, kangaroo-rats, and the rest of the small jumping desert animals. This time the convergence is in the way the body is covered with spines.

Perhaps it should be explained here that the moloch is an agama, a lizard belonging to the family Agamidae. The horned toad is an iguana, belonging to the family Iguanidae. The main difference between these two is that an agama has teeth that are set on the crests of the jawbone, and when these become damaged or worn out they

are not replaced. The iguanas have teeth set on the inner sides of the jawbones, and when they are lost or worn out they are replaced by new teeth. This may seem unimportant, but we know from dealing with other animals that the teeth usually give an important clue to family relationships.

The horned toad is about a foot long, its body flattened and all parts of the animal are covered with thorny spines, but not so much as in the moloch. One thing they have in common is that there is over each eye a particularly large spine, the base of which forms a ridge overhanging the eye. This may serve to protect the eye from sand or from intense sunlight.

The horned lizard, or horned toad, as it is more usually called, lives in the deserts of Mexico and the south-western U.S.A. The horned toads are remarkable for two things. The first is their method of burying themselves in the sand. The body is not only flattened but has a line of flattened spines, like the teeth of a saw, along the middle of each flank. To sink into the sand, the horned toad makes a number of rapid, rocking movements, goes straight down, belly first, until out of sight. Then it pops its head up and in this position, almost invisible, it waits for its food, which is ants, the same as with the moloch.

The manner in which it buries itself in the sand is this. It tilts the body to one side, digging the saw-toothed scales into the sand and flicks some of the sand on to its back. This is then repeated on the other side. So, tilting the body first to one side then to the other the whole body goes down and sand is thrown over it. Finally, with a few flicks of the tail the job is completed. The horned toad is out of sight.

The second remarkable thing about the horned toad

is that when frightened it squirts a few drops of blood from its eyes. This is quite an extraordinary thing for a lizard or any other animal to do, and it is particularly so for a desert animal, for as we have seen the one thing above all others that a desert-living animal should do is to conserve its body fluids as much as possible. It has been suggested that this blood is irritating if it gets into the eyes of small mammals, and so protects the lizard from attack. But small mammals do not attack it anyway, and it is difficult to see how a few drops of blood are going to deter any hungry animal. If anything the smell of blood should whet the appetite.

The blood-squirting-trick of the horned toad is still a mystery. We can only suppose it is a nervous reflex, like saying "Oh" when somebody sticks a pin in you unexpectedly.

The toad-headed agamas of central Asia, so called because of their broad flat head, also bury themselves in the sand, but they do so in a slightly different way. They feed on grasshoppers. Their bodies are flattened but not so much as in the horned toad, and there are nowhere on it any spines. The toad-headed agamas wriggle the body from side to side and rapidly disappear into the sand. Their eyes are protected by a scaly ridge over each eye, a sort of eave, and the eyelids are fringed with long scales like eyelashes. These not only keep out the sand when the lizard is burying itself but also flick away sand-grains blown by the wind while it is above the ground.

The horned toads and the toad-headed agamas not only sink into the sand vertically, they can also bury themselves by pushing the head down into the sand and driving themselves forward with the hind legs, in a kind of ploughing action. There are certain iguanas of the

south-western deserts of the U.S.A., however, that have carried this burrowing to a greater length. They more or less swim through the sand.

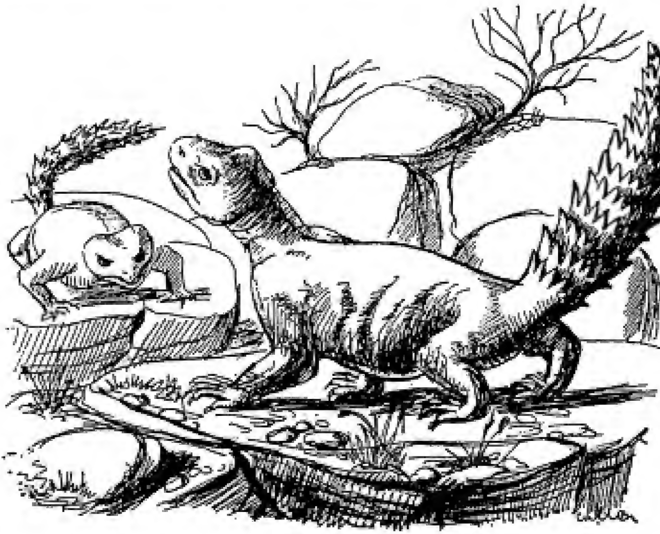
The first need of an animal for "swimming" through sand is much the same as for one swimming through water: an efficient cutwater. The lower jaw of the toad-headed agama is shorter than the upper jaw and is countersunk into it, and the tip of the snout has a sharp edge. But a cutwater is useless without something behind to drive it forward. This is provided by wriggling actions of the body and having the toes of each foot fringed with scales, making them paddle-like. As the feet are drawn forward the scales collapse, and as they are kicked backwards they open out again, to increase the area pressing against the sand.

Swimming through sand brings even more need for protection against the sand-grains. Apart from the cave-like eyebrows and the scaly eyelashes, the toad-headed agama can close both ears and nostrils with valves.

Some lizards known as skinks swim so rapidly and so habitually in the sand that they have been called sandfish. Some of these have pointed snouts with a sharp edge. All have the head armoured with large scales, but in others the front legs are weak, and sometimes the hind legs are also, and the skinks swim with a serpentine movement of the body. One kind of skink living in the desert of Pakistan, has such small limbs that they are useless for pushing the body though the sand. So while the skink is swimming by wriggling its body from side to side, the legs are folded back into shallow grooves in the sides of the body out of the way.

It would be wrong to pretend that all reptiles in deserts burrow or swim in the sand, although the ways they do

these things are so interesting that rather more space has been given to them. There are those reptiles that take refuge in crevices in rocks and there are those that run over the sand. A good example of the first is the chuckwalla of the south-western deserts of the U.S.A., especially because of the way it protects itself. If anything tries to



Spiny-tailed Agama

pull it out of its rocky retreat the chuckwalla blows up its body, jamming it in the crevice like a cork in the neck of a bottle.

Many of the desert lizards are active by day and run about over the surface of the ground. We can take the desert agama of North Africa as a good illustration of the way these live. This lizard avoids the bare sand as much as possible and keeps to those areas where there are

scattered bushes, where it feeds on grasshoppers. In the course of this, it dashes from one bush to another at a fair speed. The reason for this gives us a clue to how reptiles generally fare in the deserts, and it helps us to understand why so many of them burrow into the sand or seek the shade of rocks.

The desert agama moves about quickly not so much to seek food or escape enemies, although doubtless speed helps in this, but to avoid being in the sun too long. Reptiles cannot regulate the temperature of the body in the way mammals can. If exposed to the blazing heat of the desert sun their temperature goes up rapidly, as the heat rays are absorbed through the skin. For most reptiles ten minutes of this exposure is enough, and if at the end of this time they cannot escape from the direct rays of the sun they die of heat-stroke.

During the cold desert nights most desert lizards become stiff with the cold. Then, as the sun comes up, they begin slowly to unfreeze. When the temperature of the body has reached a point where the animal is neither stiff with cold nor in danger of heat-stroke, which is in the mornings and the evenings, it feeds, hunts and does its courting, all the time trying to keep to places where the temperature is most suitable to it. The desert agama achieves this end by using the shade of the bushes, and by running quickly from one piece of shade to another.

To a large extent much of what has been said is true of lizards and reptiles generally. Reptiles cannot stand great heat anywhere, but in deserts there is less shade and so we notice more how the lizards living there make use of what little there is or how they manage if there is no shade at all. So it is with everything else. For example, there are certain lizards that run more or less erect, on the hind feet

only. One of these is the basilisk of Central America. Not only does it run in this way but it can also cross a river running, or scuttering as it is called, over the surface of the water. It so happens that the desert iguana of the south-western U.S.A. also moves in the same way, but it scutters at high speed over the sand. The gridiron-tailed lizard of the same desert, so called because of black "gridiron" markings on its tail, does the same, a useful way of running from one piece of shade to another.

Whereas most desert reptiles are sandy or some form of brown in colour there are desert lizards in Africa that are marked with long stripes and spots. They are found all over Africa, wherever the ground is dry and sandy, and some of them live in deserts. When they scamper about in the glaring sun, their markings make them very difficult to follow with the eye. The Ancient Egyptians used to mummify the bodies of these lizards and carry them about in little boxes as lucky charms.

Mention may perhaps be made also of the banded gecko of the deserts from southern Texas to southern California. It lives on insects, especially crickets, which it stalks like a cat, holding itself high up on its legs and twitching its tail before making the final lunge.

Finally, geckoes, and other kinds of lizards, known as night lizards, have another kind of protection for the eye against sand. The lower lid covers the eye permanently, and the centre of the lid is transparent, forming a window or spectacle.

The other reptiles of the deserts are snakes, puff-adders and vipers of various species. Our native adder or viper lives on sandy heaths, and it is only a short step from that to living entirely in sand, as in a desert. The problems associated with living in deserts are much the same for

snakes as for other animals, and the way they solve these problems is much the same. Snakes avoid the intense heat either by lying up in crevices in rocks or burrowing in sand. Some even "swim" in the sand. They have no movable eyelids, but most desert snakes have a ridge or eave over the eye, to keep out the sand, and some can close their nostrils and their lips tightly to stop the sand getting in.

As with other animals, desert snakes are mainly a sandy or some other colour, and for the most part they move about much the same as any other snakes. There are, however, two snakes known as sidewinders. One is a viper living in North Africa and Arabia, and the other is a rattlesnake of the deserts of the south-western U.S.A. Both have the same peculiar method for moving quickly over loose sand, but before describing this mention may be made of another peculiarity of the viper. The scales along the sides of the body have saw-like keels. Using these with quick side-to-side movements, even when it is coiled, the viper can sink vertically into the sand, to bury itself.

For a long time it has been known that a few snakes leave peculiar trails in the sand, in the form of short straight tracks in parallel series. At first nobody could understand what these meant. But now the explanation can be given.

If you put an ordinary snake on to a smooth sheet of glass it will have difficulty in moving by the usual means, because there is nothing for it to obtain a grip with its body. What it does then is to throw coils of its body forward to help itself along. The sidewinders do something like this. They move like a coiled spring, and appear to be moving obliquely to the actual direction of movement. So they are able to move over sand, which gives no grip, much more

quickly than other snakes. Again we see this convergence: two snakes, one a viper and the other a rattlesnake, totally unrelated and living in different parts of the world, using the same method for getting along quickly over sand.

Chapter Six

INSECTS AND OTHER SMALL ANIMALS

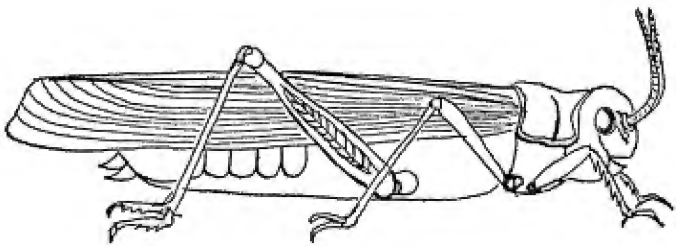
INSECTS far outnumber all other kinds of animals put together. Only a very few live in the sea but elsewhere they are found in all kinds of situations, including deserts. The best known of the desert insects is the locust.

Locusts are renowned for the way they invade the countryside and strip it of vegetation, but where there is abundant vegetation there is no desert. All the same, one of them has received the name of desert locust and it is found in both Africa and Asia. It has a number of relatives in North and South America, eighty all told, and these live in trees, in places where there is plenty of vegetation. This means that the desert locust belongs to a family of tree-dwellers and it has not entirely broken away from the family tradition. It is, in fact, not a true desert dweller although it lives in deserts. To begin with, when it swarms it moves from the dry lands into the fertile lands beyond. When not swarming, it feeds on the annual and perennial plants that come to life after the rains, keeping to the scrub belts along the rivers that form at the rainy season. There the family likeness comes out, for desert locusts climb into the shrubs just as their American cousins climb into trees.

The truth is that the desert locust needs moisture at

every stage of its life. The female lays her eggs in sand, but the sand must be moist. She may lay in what looks like dry sand, on the surface, but it is moist underneath. Were she by chance to lay her eggs on dry sand they would come to nothing. Before the eggs can develop they need to take in more than their own weight of water. Once this happens the eggs will hatch in a fortnight or less.

When the young locusts hatch they must have tender green food. If it is not to be had they die, and it does



A locust in its migratory phase

sometimes happen that they die off in large numbers because of the lack of green food. Provided everything is all right and the suitable green food is available they grow into what are known as hoppers, that is, locusts that can jump but cannot fly, and they take six weeks or less to do so.

Why then do we speak of these insects as *desert* locusts? It is because they do much the same as the human beings that live in deserts: they follow the water around. They are nomads. We have already seen that there are no regular rains in the desert, such as we are used to having, but that there are heavy rainstorms at infrequent

intervals. The heavy rains fall in one place, the vegetation springs up, the plants flower and shed their seeds, and all this takes place in a short space of time before the soil dries out again. In some places rivers run for a short while, and such places remain moist for slightly longer periods. But after one rainstorm the likelihood is that years, certainly many months, may elapse before any more water falls in that spot.

There is a saying in the desert that locusts and rain arrive together. One theory is that locusts can tell when rain is on the way and can find their way to the place where it will fall. We do know, on the other hand, that they are able to bide their time and move from one damp place to another, rather as the desert tribesmen move from one oasis to another. They are helped in this by being able to delay growing up if there is a drought, and the grown-up females are able to delay laying their eggs if the drought continues.

As we have seen, locusts are a terrible plague, eating up the vegetation in their path. In the last chapter we shall read about the efforts being made today to turn the deserts into fertile land, by irrigation. The biggest problem, should that be done in Africa and Asia, will be to keep this fertile land from being the breeding places of locusts that will eat up all the green food, and perhaps making it once more a desert.

Life in the desert is not only a matter of food and water. The burning rays of the sun, in a hot desert, also add to the difficulties, and for large animals it is not easy to find sufficient shade. The smaller animals have an advantage here. They are able to use even small areas of shadow, and when we come down to animals the size of insects there are many places where they can find shade.

A tuft of grass or a small rock will cast some sort of shadow, even when the sun is high in the sky, and where the ground is almost pure sand with only an occasional pebble there will still be tiny shadows where the temperature is noticeably lower than it is out in the direct rays of the sun. However, even an insect must do something more than sit in the shade, and so we find they are up to all sorts of tricks to deal with the heat.

The first thing we know about insects is that they are cold-blooded. This is a misleading term because it suggests that no matter what happens a cold-blooded animal remains cold. We have already seen that snakes and lizards, which also are cold-blooded animals, living in the desert are unable to stand long exposure to the midday sun, because their bodies heat up and they die of heat-stroke. Clearly, then, cold-blooded means something different from what it says. A cold-blooded animal is, in fact, one whose body is about the same temperature as that of the surrounding air. Its temperature also rises and falls as the temperature of the surrounding air rises and falls. A warm-blooded animal, by contrast, is one that can regulate the temperature of its body to keep it much the same no matter what is happening to the air around it. Our sweat-glands enable us to do this. They help us to keep cool by giving up heat from the body.

One of the things we have learned, but only within the last few years, is that certain insects, and it may be true of all of them, are also able, to a slight extent, to regulate the temperature of their bodies. The result is that when the air around them is very cold they can keep their bodies at a slightly higher temperature than normal. When the air is very hot they can keep their

bodies a few degrees below it. They keep cool by evaporation. Warm-blooded animals also keep cool by evaporation, either through sweat-glands or through the breath, by panting. Insects breathe through holes in the sides of the body, known as spiracles, and it is through these that the evaporation takes place.

When the air outside is moist this evaporation takes place less rapidly, and it has been found by careful tests that an insect can stand a temperature of 118° F. in a dry atmosphere, such as we get in deserts, better than 100° F. in a moist atmosphere.

Evaporation means loss of water. The smaller the insect the less water it can afford to lose before it begins to dry up, so other things being equal the bigger insects have a better chance of survival in the tropics generally and in deserts in particular than the smaller insects.

All bodies absorb heat from the sun's rays but some do so more than others. A spherical body has less surface over which to absorb heat in proportion to its size than one that is irregularly shaped. So a round-bodied insect such as an ant or a beetle will feel the heat less than a long-bodied insect. Dark colours absorb more heat than light colours, but metallic colours, whether dark or light, such as many beetles have, reflect back the sun's rays so that less heat enters the body.

Some desert beetles, in addition to being round-bodied and having metallic colours, also have a thick cuticle which helps to keep out the heat. Others have a pale powdery crust which reflects back the sun's rays. In addition, some beetles have a layer of air underneath the wing-cases, which helps to insulate the body from the heat of the sun, and they often have longer legs than usual, and this lifts the body up from the hot sand.

In spite of all these things we often find that desert beetles go into a state of suspended animation, a sort of reversed hibernation, at the hottest part of the day. Others burrow into the sand by day and come out only at night.

Long-bodied insects, the reverse of those with rounded bodies, use a trick which many insects use, not only those living in the tropics and in deserts. When the temperature is low on a sunny day they turn their bodies at right angles to the sun to make the most of its warmth. When the sun is hot they stand with the body pointing to the sun, to expose as little surface as possible to it.

Locusts seem to be able to bear heat well, and have a trick for avoiding the cold of the desert night. When the sun goes down it is the surface of the ground that cools off most rapidly, so as the sun sets they climb up into any bushes there may be, to keep in the warm air. Then, in the morning, when the surface of the ground is heating up, they descend to the ground once more to warm up.

Desert insects look very like the insects found elsewhere, except for the way they behave. There are beetles and there are flies some of which feed on animal droppings. They are the scavengers that we find everywhere. There are ants and termites and there are wasps. But there are no bees, for the obvious reason that with so few flowers, and what few there are blooming for only a short time, there is not enough honey for them to live on.

All hot countries are plagued with insects. Flies and mosquitoes make themselves felt only too readily, but there is one kind of insect found only in the tropics, and in countries just outside the tropics, that does enormous damage. These are the termites, often called white ants.

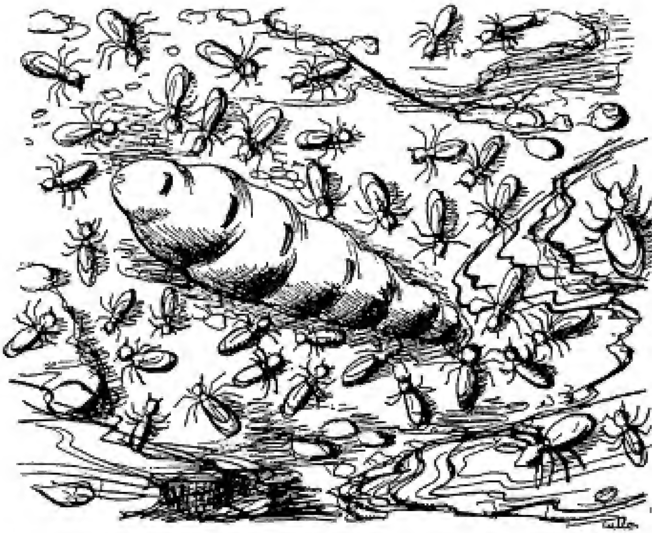
They have, in fact, little in common with ants except that they live in highly-organized colonies, known as societies. The reason why they are so troublesome is that they feed on wood and on anything made from wood, such as paper. They tunnel into the timbers of buildings until eventually these timbers collapse, and into furniture, and they will eat their way in due course, if allowed to do so, through a library of books. They are able to live on such dead materials because inside the intestine of each termite lives a colony of microscopic single-celled animals able to convert wood and paper, and other dead vegetable matter, into real food. This the termite can digest.

Termites are more nearly related to such insects as cockroaches and dragonflies, and they have been in existence for hundreds of millions of year. They are among the more primitive kinds of insects whereas the true ants came into existence much later and are altogether much more advanced. They and ants have another thing in common, however, in the way their societies are organized. Each colony of ants contains three kinds of individuals. There are the queens, the males, and the workers. Bees and wasps have much the same organization. The queens do nothing but lay eggs, once the colony has become established. The males, known as drones when we are speaking of bees, do nothing but fertilise the queens. The real work of the hive or the ant-hill, or of the wasp-nest, is carried on by the workers, and these are sterile females, incapable of laying eggs.

The termites have carried this organization still further. They have their queens and their males that are responsible for producing the many generations of workers needed to do the work of the colony. They have, in addition,

another cast of queens and males. These do not breed, but should anything happen to the reigning queen then one of this second caste of inferior queens takes her place.

There are further castes in the termite colony. There are workers, and these may be of more than one kind,



Termites, showing the Queen surrounded by workers. Two soldiers can be seen on the right of the drawing

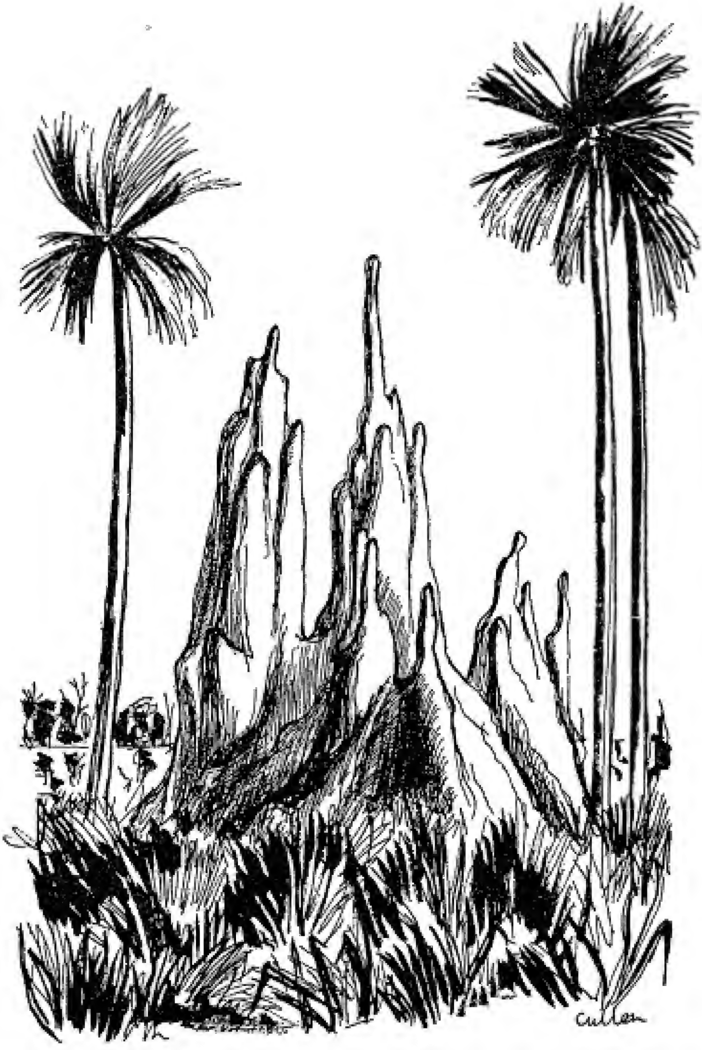
and there are soldiers, and these may be of more than one kind also. The soldiers have large heads in proportion to their bodies, and these may be armed with large jaws. Some soldier castes have only short jaws but have a horny beak projecting forward from the head, and other soldier castes can eject a poison at an enemy. When the workers go out foraging they are protected by the soldiers,

the main enemy being ants, and in the tropics ant colonies sometimes have a soldier caste to protect their workers. The soldier castes of both termite and ant colonies also protect the nests when these are attacked.

Termite nests, or termitaria as they are called, are a conspicuous feature of the landscape in many tropical countries. They are made of mud cemented with saliva which, when hardened, needs a pickaxe to break it. Some termitaria form huge mounds or towers, anything up to sixteen or even twenty feet high. Other termites make their nests below ground, the only signs then being small mounds thrown up in places; while others make their homes in rotten tree-trunks.

All this explanation is necessary in order to understand some of the changes needed for one kind of animal to live successfully in a desert when its relatives are found in the more fertile lands. Social insects have many advantages over those that live solitary lives, and that is one reason why ants and termites are able to live in almost any kind of situation. All the same, termites do best where the soil is damp, but there are some that seem to do well even in dry areas, and in addition there are about nine different kinds in the Sahara alone, which is one of the driest and most barren of all deserts. Yet in the Sahara termites, and ants too for that matter, are everywhere. Any isolated tree or any clump of vegetation well away on its own will shelter one or more colonies.

Where there is any vegetation at all the termites feed on the stems and the roots, on the fragments of dried grass and other vegetation lying around. They will also feed on the beams and rafters of any buildings that may be put up, such as beams and rafters of barracks or buildings of other military outposts. Around the oases they



Termite nests in West Africa. These mounds often reach 20 feet in height

may attack the trunks of palms, but only the dead wood in them. The sparse vegetation in the more barren parts of the desert are particularly vulnerable after a long drought.

Some termites live in parts of the Sahara where there is no vegetation at all, and it was something of a mystery how they managed to do this. It seems, however, that they feed on what might almost be called fossil wood, on the trunks of trees that flourished there long before the Sahara became a desert and which now lie buried under the sand.

There are no large termitaria in the Sahara, for instead of building upwards the termites build sideways. Their nests are just under the surface of the ground and take the form of long galleries or tunnels anything up to 200 yards long. Some termites go deeper than others, and in one kind, that has its tunnels deep in the soil, the queens, the males, the workers and the soldiers are all blind. All the termites, whether they are blind or whether they have eyes, seem to be able to find water. They will tunnel down, perhaps a hundred feet, bringing up water in their mouths, to keep the tunnels of their nests moist.

Nine kinds of termites are found only in the Sahara and belong to different species from those found elsewhere. It is different with the ants of the Sahara. Nearly seventy different kinds have been found but these belong to species living all along the shores of the southern Mediterranean. They are not desert insects in the strict sense but have spilled over into the deserts. Fifteen of them have, however, an importance in the life of the Sahara.

The ants living in the northerly latitudes, in this

country, for example, do neither very great harm nor very great good. They are, all the same, part of the balance of nature, and leaving man out of the picture any harm they can do is offset by the good they may do. It is when ants or any other animal clash with our interests that we say they are harmful. Thus, when ants come into the house and into the larder, and crawl into the jam and the sugar, we speak of them as a nuisance. In the garden there are some ants that treat greenfly as we do cows. The greenfly give out a honeydew which the ants lick up, and the ants in return protect the greenfly. They will even carry them on to fresh plants, just as we take cows to fresh pastures. Considered as a natural event this is all very well, but when the ants plant the greenfly or the blackfly, as the case may be, on a favourite peach tree or a prize carnation, then their interests clash with ours and we consider them harmful.

Since a desert is barren waste already, it seems unreasonable to say that ants there are either good or bad. The fifteen species of ants most common in the Sahara do one of four things. Some of them feed on seeds only, and they spend their whole time collecting these for their granaries underground. The fewer the seeds there are when the rains come the less the vegetation there is likely to be. These ants are doing nothing to decrease the amount of desert, therefore they may be called harmful. There is the second kind of ant that puts greenfly or blackfly on to what few plants there are, and protects and tends them. Since these suck the juices of the plants, so stunting their growth, the ants that tend them may also be classed as harmful. The third class of ants are neutral. They eat some seeds but they also kill insects that would otherwise damage the vegetation. The fourth

class we should classify as wholly beneficial. They are large ants with silvery bodies that destroy other insects, including termites, which eat the vegetation.

It was said earlier on that termites eat only dead wood and do not interfere with green plants. As we have seen, some desert plants dry up between the infrequent periods of rain but have the power of coming to life again as soon as they are soaked in water. They are not truly dead, but to a termite a dried up plant is as good as truly dead wood, and in so far as they eat such plants they are reducing still further the scanty vegetation.

Briefly, then, the scanty vegetation in deserts is being made still more scanty by termites and by some kinds of ants. Such insects are helping to maintain deserts, if not helping to create them, and to expand those deserts already in existence. The harmful work they are doing is, however, offset to some extent by the work of the large silvery ants that prey upon them.

Throughout the tropics ants and termites are enemies. Whenever they meet there is a fight. So what with plants struggling to survive against insects that injure them, and some kinds of ants preying upon the ants and termites that eat plants and their seeds, we may truly speak of a continual desert warfare. But it is a warfare that has been going on for a very long time, as long as ants have been in existence, and it is only within the last twenty years or so that any serious study has been made of the lives of the desert insects. It is impossible to say, therefore, whether the results of this warfare have been the creation of deserts or the enlargement of deserts already caused by other circumstances, or whether the activities of the ants and the termites cancel each other out. The likelihood is that the end result is to

keep scanty vegetation a little more scanty and no more.

The other class of insects that have a social organization includes bees and wasps. There are no colonies of wild bees in the Sahara because, as we have seen, there are few blossoms, and bees also need plenty of water in addition to nectar to make the stores of honey necessary for their existence. Even in the oases there are no bees, wild or in hives, because for three-quarters of the year there are no flowers. There are no colonies of wasps but there are hunting wasps that lead solitary lives and spend their time killing insects and caterpillars. There is, however, one kind of hornet—and hornets are really large wasps—and this feeds on insects that damage the vegetation.

Although there are no bees to store food this does not mean there are no insects at all with thrifty habits. In the desert areas of South America live the umbrella-ants, or leaf-cutting ants, also known as attas. They can be seen in long columns, each ant carrying a piece of leaf over its head, like a parasol. They take these pieces of leaf to their nests, chew them into a pulp on which the spores of fungi will germinate. It is a kind of mushroom-farming, and the fungi are eaten when other foods are scarce.

For that matter, the ants that eat seeds are also thrifty in that they store some of them against the time when food will be scarce. This raises a very natural question. If the ants take seeds into their burrows and store them, surely some of the seeds will germinate sooner or later? Should this happen, then the ants could be said to help diminish the deserts by planting seeds where they perhaps would not otherwise be found. In fact, it does not happen

because in the tunnels where the stores of seeds are kept the ants plaster the walls with saliva to make them waterproof.

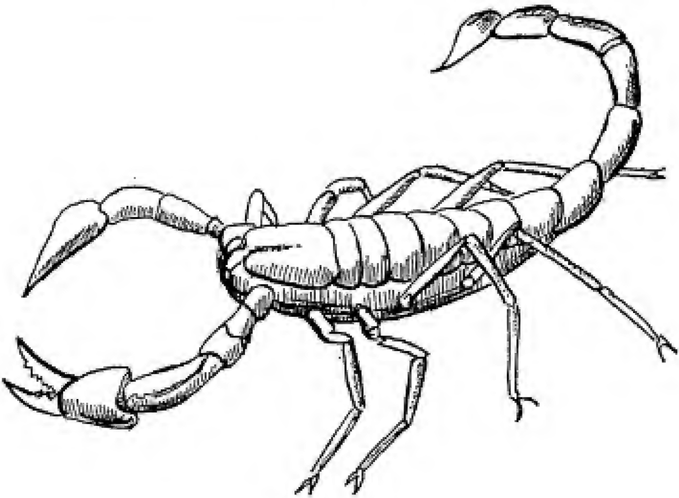
Perhaps the most extraordinary form of food storage is seen in the honey-pot ants of the deserts of Australia and North America. Some of the workers in each colony act the part of living containers. In times of plenty, just after a fall of rain, the foraging workers come back to the nest with their crops filled with sweet sap from the plants that have sprung up. They empty their crops into the throats of these special workers whose abdomens become swollen to a large size with the store of juices. These special workers are known as repletes. They do not digest the juices and being unable to move about because of the load inside their bodies, they hang by their legs from the ceilings of the underground tunnels. Then, when times of scarcity come along, the other workers turn to the honey-pots and relieve them of some of their stores. The honey-pot worker, on being approached by one of her fellow workers, allows some of the juice to trickle out of her mouth, to be lapped up by the hungry worker.

In the Central Desert of Australia the aborigines have no sugar or honey. They seek out the nests of the honey-pot ants and dig out the repletes and, holding each by the head and thorax, bite off the honey-filled abdomen and eat it.

The ants and termites are easily the more interesting insects living in deserts, largely because being in colonies they are able to make so successful a living under these very difficult conditions, and it is the ways in which they do this that make the best reading. Social insects are also more easy to find and to study, which is another reason why we know more about them, and this calls

to mind the mention of caterpillars earlier in this chapter.

For hundreds of years past it had been noticed that each year several kinds of butterflies fly north in swarms across Europe. The large white butterfly that does so much damage to cabbages is one of these. The swarms



A scorpion

have been seen flying across North Africa, the Mediterranean, across Spain and France and the English Channel and then northwards across the British Isles. It is only within the last twenty to thirty years that a serious study of these migrating butterflies has been made. They seem to come from the lands to the south of the Sahara, but only once has the start of such a migration been seen. That was in 1869, when some people riding on camels across the desert behind Suakin, on the Red Sea, noticed

the grass moving as if being violently shaken, but there was no wind. It was found that the grass was being shaken by thousands upon thousands of butterflies emerging from their chrysalids. Half an hour later they had all flown off in a swarm.

Insects belong to the kind of animal known as invertebrates, or animals without backbones, and so do scorpions. They are not insects but distant relatives of spiders and like them have four pairs of legs as against the three pairs of an insect. Scorpions have a bad reputation for being ferocious and poisonous. They carry in front a formidable pair of claws, and the long slender tail carries a poison-bearing sting at its end. When a scorpion strikes it brings the tail over its back and thrusts the pointed sting forwards. At the same time muscles in the sting contract and force poison out of the poison-gland and into the wound. Many scorpions are quite harmless to men, but the sting from others causes painful swellings, and occasionally death may result from a scorpion sting. But on the whole scorpions are as anxious to avoid us as we are to keep away from them.

Scorpions are at home in the hot sandy places, where they feed on insects and spiders. Most of them are more active at night, resting by day in burrows in the sand which they dig for themselves, or under stones. They show all the features we should expect to see in true desert animals, even when they are living away from deserts. They move about quickly. They can go for long periods without food. And to a large extent they get the moisture they need from their food. It is usually said that they never drink, but this is probably false. Scorpions are sometimes kept in captivity in this country, in zoos, or in laboratories for study. When such a captive scorpion

is given, in addition to insect food, a small pad of cotton-wool soaked in water it will daily lick the cotton-wool. From this it is fairly safe to assume that when free in the desert a scorpion probably drinks dew. Equally, it is probably safe to assume that it can survive for long spells with no more moisture than is contained in its food. This, indeed, is a true desert character: to be able to go without water yet to take it when the opportunity offers.

From the ice-bound lands of the polar regions to the heat of the tropics, there are very few places where snails cannot be found. They are apt to pass unnoticed because, like the snails in our gardens, they come out mainly at night and especially after it has been raining. During dry weather they retreat into the earth, under stones or in crevices, seal the entrance to the shell, thus preventing evaporation of moisture, and are able to escape the rigours of the weather by merely resting within their shells until better times come along. So, although we may think of them as animals with delicate bodies, they are able to live successfully in the deserts, hiding away until the rains come and vegetation springs up for them to feed upon.

Nothing could illustrate better the life of a desert snail than the classic story of the specimens in the Natural History Museum in London. A naturalist crossing a desert collected some snail shells, which seemed to be empty. On his return to London, these shells were presented to the Museum. They were duly gummed to a small tablet of wood and put in a showcase in one of the galleries, with a label to tell visitors what the shells were. All went well until several years later, when the snails were found wandering about inside the showcase.

When the shells had been picked up in the desert their occupants had retreated far into the inner recesses and could not be seen, so the shells were assumed to be dead shells. The story shows how long desert snails can go without feeding, and how securely they retreat into their shells during the dry periods.

Chapter Seven

COLD DESERTS

A DESERT has been defined as a deserted place which, if we choose to abandon it or neglect it becomes a desert, but if we take an active interest in it may be arid but is not a desert. The writer obviously had the hot deserts in mind, but to some extent the definition is also true of cold deserts, although they could be called perhaps barren rather than arid, for one of their chief features is the amount of ice and snow they carry. From this we should expect to find the cold deserts in the polar regions, but there is one important exception, the Gobi desert. Relatively little is known about the Gobi, but the largest of the cold deserts, the continent of Antarctica, after having been neglected for a long time, has within recent years become the focus of a great deal of attention; and some of the cold deserts of the north polar regions have also been much used in recent years, for military considerations.

Gobi is a Mongolian word for desert, and the Gobi desert occupies the centre of a high plateau in Mongolia, a territory to the north of the Chinese People's Republic. It is nearly 2,000 miles long and up to 400 miles across, a barren wilderness of bare rock, gravel and sand within which are areas of firm sand bearing a scanty vegetation, but a large part of it, although also treeless, has

a seasonal covering of grass and forms a vast prairie. Nomadic tribes, living in tents, move from place to place to pasture their flocks of sheep, their Bactrian or two-humped camels and their horses. In the Gobi the climate is marked by bitter winds, a winter that lasts for more than nine months of the year, and a brief summer during July and August, and even in this short summer snow may fall. Even more barren is the continent of Antarctica.

There had long been talk of a vast southern continent, but it was not until the late eighteenth century that Captain Cook crossed the Antarctic Circle to discover the South Sandwich Islands and South Georgia, but only after immense difficulties from the strong winds and outbreaks of scurvy among the crews. These are two groups of islands among the many that lie in the subantarctic seas around the main land-mass, the continent of Antarctica, five million miles in extent, or half as large again as Europe.

In 1819, forty-four years after Captain Cook first sailed into its waters, Edward Bransfield reached the New Shetlands, another group of subantarctic islands of which he wrote, that he had "very faint hope of ever being able to speak well of its fertility". He also wrote of "a beach with seals so stowed in bulk that it seemed dangerous to approach them", of immense crowds of penguins through which they had to cut lanes, slaughtering the penguins as they went in order to make their way inland, of whales, and of "shoals of sea elephants, asleep".

We could very well take Bransfield's words as symbolic of the whole of Antarctica: a land of little fertility, its shores occupied by numerous sea animals. Almost the

whole continent is covered with a sheet of ice several thousand feet in thickness for the most part. Occasionally a small carpet of lichens and mosses may be found, and even more rarely a few flowering plants. In places bare mountain protrudes above the icy plateau. And the largest land animal is a wingless mosquito one-fifth of an inch long. The mass of ice covering the continent is formed of compacted snow which gradually moves outwards under its own weight and breaks off into the sea as icebergs a few yards long to as much as fifty miles long.

The names by which the Antarctic islands, and the various parts of the continent itself, are known act as guides to the history of exploration of these parts during the hundred years or so after Cook's first visit. In 1821, an American sealer went south to see what the prospects were of hunting the seals. His name has been given to the Palmer Archipelago. Ships' masters from a London company of sealers and whalers included Weddell, whose name is immortalized in the Weddell Sea. There were French, Belgian, German and Norwegian expeditions, but these were mainly interested in the approaches to the continent, especially for the prospects of whaling and sealing. They are recalled in such names as Charcot Island, d'Urville Sea, Wilhelm Land and Queen Maud Land. Then came the race to reach the South Pole. The first attempt to reach it was made by Shackleton, in 1908-9, who came within 160 miles of the Pole. On 14th December, 1911, the Norwegian explorer, Amundsen, reached the Pole, to be followed by Captain Scott, on 17th January, 1912, who with his four companions died on the return journey, hampered by bad weather and weakened by the gruelling journey and lack of food.

Even in the short southern summer temperatures are seldom above freezing point, and in winter temperatures of 70 or even 100° below zero are the rule. There are strong winds, snow-storms and blizzards, but never rain. In the words of one of the first American expeditions who were using aeroplanes: "If there were light westerly winds, low clouds and fog would lie for weeks over the ground. When winds were from the east or south, the sky was clear and it was necessary to seize the opportunity for a flight quickly, because as the air poured down the coastal passes from the plateau, the velocity at the base built up dangerously. There were only elusive periods of suitable flying weather." Winds can sometimes blow at 120 m.p.h. For those who explored the continent without the aid of aeroplanes, conditions were no better. One of these, Sir Douglas Mawson, the Australian explorer, tells of ". . . drifting snow which poured fluid-thick over the landscape; for many days it was impossible to see one's hand held at arm length. Such weather lasted almost nine months". Cherry-Garrard who with two companions went in search of the eggs of the emperor penguin, had to make a journey of five weeks in utter darkness, with the temperature 60 to 77° below zero—and a blizzard thrown in, that blew their tent away. He has described his adventures in a book entitled *The Worst Journey in the World.*

Such are the conditions of the largest and most famous of the world's cold deserts, a continent bare of vegetation, without land animals of any consequence, and apparently without mineral resources. Yet, since Cook first went across the Antarctic Circle, there has been ever-increasing interest in it. Then, during the course of the International Geophysical Year, which lasted from July 1957 to

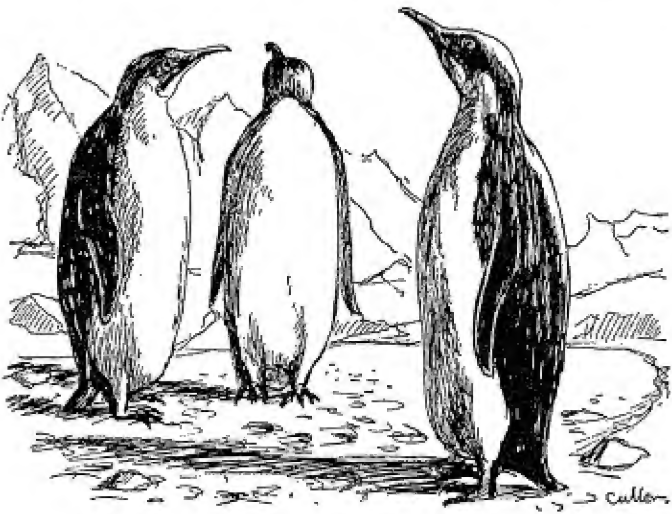
The Antarctic with King Penguins in foreground

December 1958, when the nations of the world combined in an ambitious world-wide programme of research, ten nations took part in the greatest exploration of the Antarctic continent that had ever been attempted. Teams of scientists either crossed the continent, or were landed on it, whereas previously the only living things to make the journey inland with any frequency were seals who were approaching their end. It has been said that when a seal is wounded, or otherwise senses its approaching death, it retires thirty miles into the interior or on a mountain 2,000 feet high "there to die in solitude and dignity".

In spite of the barrenness of the continent, there are a few rocky beaches which, during the summer, are free of snow for a few weeks. It is then the petrels, terns and gulls from neighbouring seas come in to nest, as well as millions of penguins. The emperor penguin, unlike the others, nests in the middle of winter, and it stays on or near the edge of the continent all the year round. This is the penguin whose eggs Cherry-Garrard went to look for in "the worst journey in the world". He was not merely collecting eggs but was anxious to learn something about the way the chick develops. Unfortunately, all the eggs he secured contained no embryos. It was many years later that a thorough study was made of the breeding habits of the emperor penguin, and since this bird can justly be described as the largest permanent inhabitant of the Antarctic continent, it is fitting that something more should be said here about the results of these later studies.

In the temperate latitudes birds build their nests, lay their eggs and bring off their young in spring and early summer. This is the time of the greatest abundance of

food and it is also the time when the weather is most genial. We are so used to this that the idea of a bird nesting in the dead of winter seems absurd. There is, however, another consideration. Birds nest at such a time that the young shall be old enough to survive the bad weather when it arrives. It is for very much this



Emperor Penguins of the Antarctic

reason that the emperor penguin lays her eggs in the depth of the Antarctic winter, as we shall see.

To understand how it was possible to study the whole life-history of the emperor penguin, something must be said about British scientific work in the Antarctic during the twentieth century. In the early years of this century the whales in the Antarctic seas were being hunted on such a scale that fears were held that they

might soon be wiped out. In 1925, the Colonial Office decided on a scheme for the wholesale investigation of whales and whaling, to include a thorough study of everything connected with the seas around the Antarctic continent. The Discovery Committee was set up, so named because it was to use Scott's old ship, the *Discovery*, fitted up as a research vessel. In 1926, a second vessel was acquired, the Royal Research Ship *William Scoresby*, and in 1930 the old *Discovery* was replaced by a ship specially designed for the work, the R.R.S. *Discovery II*. Year by year, visits were made to the Antarctic Ocean and adjacent seas, with the result that the distant, inhospitable waters of the southern polar regions are better known scientifically than many of the seas nearer home. The Discovery Committee is now included in the National Institute of Oceanography.

In 1943, a new scheme of investigation was started, this was more concerned with the land. It was based on the Falkland Islands and was called the Falkland Islands Dependencies Survey, or FIDS. The survey was to cover South Georgia, the South Sandwich Islands and New Shetland Islands, and also that part of the continent known as Grahamland. It was while sledging over the sea ice in the region of Grahamland that some members of FIDS came across an emperor penguin. But this bird was not alone. On a group of islands near by was a rookery with over a hundred of these penguins, with their chicks. The men camped near the birds for two days, photographing them and watching them, and in the following winter they returned to spend nearly three months studying them.

Emperor penguins are the largest of the living penguins. They stand over three feet high and weigh nearly a

hundred pounds. There was another penguin, long since extinct, that stood nearly six feet high. Like all other penguins, the emperors find their living in the sea, where they feed on fish and squid, and like all warm-blooded animals that live wholly or mainly in water they have a layer of fat under the skin that serves not only to insulate the body but also as a reserve of food. They differ from most other penguins in not making a nest. Some penguins use a burrow in the ground, others make a crude nest of sticks or of pebbles, but the emperor penguins use their feet for a nest. They have to do so, for where they nest all sticks and pebbles are buried under several feet of ice.

The Antarctic winter starts in May, a time of temperatures below zero, with the seas frozen over, and darkness or at best twilight throughout the night and day. Fortunately, for those studying the penguins, the birds showed no fear and would often huddle around their human visitors, helping to keep them warm. They were able to see how the female lays her single egg and cradles it for a few minutes on her feet, to keep it off the ice, before it is transferred to her mate to hold. This is done by the male, who scoops the egg off the female's feet with his bill, on to his own feet. Then, steadying it with his bill, he is able to lower a fold of the skin on his abdomen over the egg, holding it as in an incubator. This done, he settles in a hunched-up position while the female turns and goes away across the ice to the sea, which may be anything up to a hundred miles away.

For sixty days or more, the female is away, feeding. Meanwhile, the sole responsibility for the care of the egg rests on the male. The most he can do is to shuffle about, keeping the egg always in its incubator, and

huddling with the other males similarly burdened when the blizzards blow. During these sixty days the most he can eat is snow, and he has to depend on the fat stored up in his body. At the end of that time, although she is so far away, and has had time to forget mate, egg and all, the female, guided as if by some inner clock, returns, just as the egg is about to hatch. Moreover, although for the sixty days she has been eating all she could catch, she makes the hundred-mile journey back with her crop filled with fish and squid ready to feed them to the newly-hatched chick. It is now her turn to take care of the chick while her mate goes away to break his fast, but from August to December the parent birds take it in turns to feed and to look after their offspring. By the end of December the ice is beginning to break up and to float out to sea, but the parent penguins continue to feed their chick, as it floats on an ice-floe, until by the end of January it is able to dive into the water and swim, and hunt for itself.

Perhaps one of the most remarkable features of this most remarkable life-history is that should the female return late the male is able to feed the newly-hatched chick for a few days with food secreted by glands in his crop.

From the time the egg is laid until the chick can fend for itself is nine months. For the emperor penguin to continue to live on the Antarctic continent it is essential that the egg be laid in the depths of winter, so that the chick should be ready to look after itself at the most favourable moment—as the sea-ice begins to break up. It is essential, also, for the parents to be able to spend long periods of time apart. Were they, as most birds, to share the duty of feeding the chick each day, so much time and energy would be lost in travelling across the

ice and back again that neither parents nor chick would survive.

There is one more thing to be noted. The edges of the Antarctic continent dive steeply into the sea instead of going down in shelving beaches. The waters of the Antarctic Ocean are wonderfully rich in marine life, rich in plankton and fish, and this abundance of food comes inshore because the waters are deep right up to the edge of the land. The very numerous seals, as well as the penguins, are able therefore to feed sumptuously without making long journeys out to sea, during the summer months when food is most necessary to them.

The north polar regions are markedly different from those at the opposite side of the world. In the southern hemisphere, the main continents diminish in size southwards and their southern extremities, that of South America in particular, are like horns directed towards a vast southern ocean, at the centre of which is a large continent, the Antarctic continent. In the northern hemisphere the continents broaden northwards, and the polar region itself is an ice-locked sea with no land around the North Pole. There is, therefore, no large single cold desert to correspond to the continent of Antarctica, but there is one which, although smaller, is just as barren as it. This is the Greenland ice-cap.

Apart from Australia, Greenland is the largest island in the world. It is 1,650 miles long and 650 miles wide at its broadest point. Its northern coast is 440 miles south of the North Pole and is the most northerly land in the world. During the winter the sea freezes so that there is continuous ice from Canada to the west coast of Greenland, and it was probably from the west that the first settlers on Greenland, the Eskimo, came. They

were hunters, of seals and whales, drawing their living, like the emperor penguins of Antarctica, from the seas. But they also hunted animals living on land, such as the musk-ox and the caribou, for although the interior of Greenland is occupied by an ice-cap, two great domes of ice, in places as much as 10,000 feet high, the borders of the island are habitable. It is said that when the Icelandic Viking, Erik the Red, landed on the coast of Greenland in the ninth century A.D., he called it Greenland to encourage his people to settle there, to build their farms, grow corn and rear their herds of sheep and cattle. So although the centre of the island is an ice-desert, the fringes are fertile and can support flourishing communities of people.

Just as the hot deserts can merge into semi-desert or arid steppe, or semi-desert can exist on its own, so also do we find ice-deserts and those regions which are semi-desert because of the cold conditions. Such semi-deserts are found along the northern parts of Asia, in Siberia, and the northern parts of Canada and in Alaska. In such places the winters are hard and long, but although the summers are short there is then abundant water from the melting snow and ice, and for a brief period the vegetation flourishes. In places the grass can be lush, although there are no tall trees, only small stunted trees looking like low bushes. The vegetation is, however, sufficient to support even large animals like the musk-ox and the caribou in Canada and the reindeer in Europe and Asia. These feed abundantly through the short summer, laying up a fat reserve, and survive through the winter by digging beneath the snow for lichens and mosses, or by migrating southwards. There are smaller animals also, and these either follow the habits

of the larger animals or else they hibernate. There are also flesh-eaters, like the wolves and the Arctic foxes, that feed mainly on the smaller mammals; and these often eke out the winter by killing small rodents in the summer and caching their carcasses among the rocks for winter feeding.

As in the Antarctic, the northern polar seas are rich in marine life, supporting large populations of seals and whales—until these were grievously thinned by the sealers and whalers. In the polar regions also lives the large polar bear which, unlike all other bears, is a flesh-eater, feeding mainly on seals or on carcasses of whales cast up on the shore, and therefore, like the penguins, drawing their sustenance from the seas.

Where there is such abundance of large animals, even although they may be enduring hard conditions, the regions they occupy can hardly be called desert. At best we must speak of them as semi-desert. Even so, it is of interest to compare them with the animals living in the hot deserts. The first thing we notice is that with them the main problem is not a lack of moisture but of water locked up in the form of ice or snow, both of which can be taken into the body through the mouth to quench a thirst. The second thing is that they do not have to contend with intense heat but with intense cold. Yet although they have to contend with opposite extremes the animals of the hot and the cold deserts have several features in common, but they also have at least one marked difference.

Large animals, like the camel, medium-sized animals, like the fennec fox, and small animals, like the jerboas, living in hot deserts, where temperatures are very high by day, have coats of long hair. These keep them cool

by day and warm in the cold desert nights because hair traps air, and air is the best form of insulation, against either heat or cold. It has been found, for example, that the best tent for use in polar conditions is one made of light material but constructed of two walls enclosing six inches of air. The Eskimo does not wear several layers of thick warm clothing but a simple dress consisting of a parka, a form of tunic, and loose trousers, the parka more especially designed to enclose air and to keep the air trapped no matter what position the wearer may assume. Animals living in intensely cold situations all lay in fat, as a food reserve, as indeed do hot desert animals, but in cold deserts and semi-cold regions the layer of fat also helps as an insulator to the body. But, in addition, in the cold regions large animals, like the polar bear and the musk-ox, medium-sized animals like the Arctic fox, and small animals, like the lemmings and the ground squirrels, also have coats of long hair, which insulate their bodies still further from the cold. One of the reasons why the musk-ox is so scarce today is because its coat makes an ideal sledging robe. And one of the reasons why Arctic Canada was opened up to human settlement was that the trappers went farther and farther north in search of fur-bearing animals whose pelts could be made into coats for protecting human beings from the cold.

A further similarity between the animals living in the hot deserts and those in the cold semi-deserts is that the soles of the feet tend to be hairy. In the hot deserts this gives a grip on moving sands, in cold regions the hairy soles act as snow-shoes, preventing their owners from sinking into soft snow or slipping on ice. If not that, the feet are splayed. We have seen that the feet of the camel

Polar Bear and cub, with Bowhead whale in distance

are splayed, and so are the hoofs of the caribou and reindeer, so that a herd of these animals walking over hard ground make a characteristic sound. As they lift their hoofs from the ground the two halves of each hoof come together with a click like the sound of castanets.

Polar animals tend to have larger bodies than corresponding species living in milder or hotter areas. The

larger the volume of the body the smaller is the surface in proportion, and the smaller the surface the less is the loss of heat from the body by radiation. In addition, the ears are small in proportion to the rest of the body and the limbs are stout. The polar bear is a good example of this. It is a condition which is the reverse of what we found in animals in hot deserts. The camel for example has long slender legs and a long slender neck, both of which increase the surface of the body exposed to the atmosphere, and therefore offer a greater surface for the loss of body-heat. The fennec fox and the bat-eared fox have very large ears that perform the same function. By contrast the ears of the Arctic fox are small.

A most striking example of this rule is seen in the hares of North America. In the southern U.S.A., the native hares, known as jack rabbits, have long ears and long legs. As we go north from the U.S.A. and into Canada, the various species of hares have progressively shorter ears and legs, until in Arctic Canada we come across the snowshoe rabbit and the Arctic hares with large rounded bodies, small ears and relatively short legs.

Alaska, the large territory in the extreme north-west of North America, can be taken as a good example of a cold semi-desert. There the snow persists for most of the year and the ground is permanently frozen to a depth of many hundred feet. With the short summer the earth may thaw to a depth of a few inches or at most a few feet, especially in areas of good drainage, where the soil is sandy and raised into hillocks. These form "islands" surrounded by perma-frost, as it is called, and they are inhabited by ground squirrels. These lack the bushy tail of tree squirrels, and they have shorter legs and smaller ears.

The most extraordinary feature of the ground squirrels of one of these areas of semi-desert, Point Barrow in Alaska, which is where these particular squirrels are found, is that they successfully cram three months of active life into every twelve months of the year. For the rest they sleep. They awake in early May, while the ground is still covered with snow, and they feed on the stores they have accumulated in their burrows the previous year. Then, as the snow melts and the air warms up a little, the vegetation springs to life. Like the flowers in the hot deserts, the plants on the Barrow grounds have to make the most of a short growing period. The squirrels have to make the most of this short growing period also, to feed, to mate, to bring forth their young, to prepare their burrows for the next winter, to lay in a store of fat, and a store of food in the burrow, and all this within the space of three months.

More remarkable than the lively activities of the adult squirrels is the way the young are born and grow up in this brief time, sufficiently to be able to feed themselves, dig their own burrows and prepare for the next winter. They are born naked and blind, as is usual with squirrels, and their eyes do not open until they are twenty days old. But in July, twenty-two days after they are born, they leave the burrow where they have up to then been fed by the mother, and start to forage for themselves. At first they do not wander far from the burrow in which they were born, but by the time they are forty-two days old, they are fully grown, have wandered far afield, dug a burrow of their own and started to stock it with food against the time, nine months later, when they will emerge from their first winter sleep, to have their own families.

Old and young, they seem to be aware of the urgent need to use every available minute. Rain, cold, bitter winds, nothing keeps them under cover. They feed ravenously, and having done so return to their burrows with their cheek-pouches stuffed with food to be stored, and with a bunch of grass between the teeth to line the nest. They feed on leaves, flowers, stems, roots and seeds. They clear up anything edible they can find, even the carcass of one of their own kind. Nothing comes amiss. Food they must have, of whatever kind it may be, and no time wasted. And yet, and this is the most extraordinary thing, although during these summer months the sun is above the horizon throughout the twenty-four hours of each day the squirrels maintain a working day of only seventeen hours.

This short working life of the ground squirrels recalls that of some of the animals living in hot deserts, especially the lizards. They also, but for different reasons, as we have seen, spend long times asleep, but make the most of the infrequent opportunities for ravenous feeding and the laying in of food reserves in their bodies.

Chapter Eight

MAKING THE DESERT BLOSSOM

A GLANCE on the map on page 21 shows that hot deserts occupy a fair proportion of the total land surface of the globe. In addition there is a large amount of semi-desert which is not included on the map. Today the human populations are growing rapidly and one of the most urgent problems is to grow more food. It is possible to devise methods for growing more per acre, but there is also the need to provide more acres for agriculture and husbandry. The problem is made the more urgent because as populations grow so do towns increase in size swallowing up good arable land. The result is that men are looking more and more at the deserts and the semi-deserts to see whether these can be reclaimed.

Some deserts have been caused by natural agencies, as we have seen, but many have been created by man. In both, the causes of the land being barren can be explained in simple words: too much sun, too little water. This does not apply, of course, to the cold deserts, where the trouble is due to too much water locked up as ice and too little sun to melt it. In this chapter, however, we shall not be concerned with the cold deserts.

We who live in the temperate regions often complain about our weather. We have too little sun and rain is apt to fall at all times of the year. But we rarely get torrential

rains, and droughts are never as serious as they are in the warmer latitudes. One result of this is that land is productive. Crops are usually good, and, as a rule, if one crop should fail there is usually another in abundance to counter-balance this. And everywhere is green.

Those who can afford to do so like to go for their holidays to one of the Mediterranean countries, to the South of France, to Spain or Italy, or to North Africa. There they can be reasonably sure of summer sunshine. So far as the soil in these countries is concerned this is bad. It becomes baked by the sun and when the rains do fall they are heavy and the water runs off the land and is lost. The position is made worse by what man has done.

Centuries ago the Mediterranean countries were the centre of civilization. At some time or another each country in turn held sway: Ancient Egypt, Greece, Rome, the Arabs and the Spaniards. Their countries were fertile, but today, in all of these, the soil is impoverished. They have cut down their trees, for building, furniture and fuel, and when forests are destroyed many things happen. Trees catch the rain and their leaves and branches drip letting the water down gently on to the earth after the rain has ceased. The roots of the trees hold the soil together. Remove the trees and the torrential rains wash away the topsoil, carrying the particles away to the rivers and down to the sea, leaving the barren subsoil. Without the trees to protect it the soil is whirled away by the winds.

This wearing away of the fertile topsoil and the creation of a barren desert is known as land erosion. Felling the trees and the loss of the soil by winds are not the only causes. There are such things as over-grazing the land with cattle, bad use of the soil in farming, the keeping of herds of goats that eat almost every green leaf and at the same time

cut the soil with their sharp hoofs so that nothing will grow. But the destruction of the forests is one of the first causes of land erosion. Therefore, it is simple to see that to turn desert into fertile land we need to reverse the process by which fertile land becomes desert. Instead of cutting down trees we must plant them.

Planting trees is not a simple matter even where there is fertile ground. The work is expensive in labour and a period of years must elapse from the time of planting the seedlings until the trees are large enough for their roots to do the work effectively of holding the soil together. Merely to plant rows and rows of trees in the desert would serve no purpose. They would die almost as soon as planted. Two things more are needed: a regular supply of water and humus in the ground for trees to feed upon. Humus is the completely rotted vegetation or animal waste that gives life to the soil and food for the plants growing in it.

There is, of course, a simple answer to the problem of reclaiming desert lands. Since deserts grow by spreading outwards, the way to make them grow less is to cause them to contract. That is, you start on the edge of the desert, where the land is not absolutely hopeless for growing things, even though it may mean hard work, and you make the edge of the desert recede. The second obvious thing to do is this: since in reclaiming desert lands you need to be well equipped for the battle, it means studying the problem intensively before you start. A good example to illustrate this is found in the work done in the Soviet Union in reclaiming the desert lands of central Asia. We cannot deal with all the work that is being done, and it will be sufficient to take one area only, that lying between the land-locked seas, the Caspian and the Aral Seas, known as the Kara-Kum.

Although the area in question has been drying up for thousands of years, the situation has been made worse in the past by the cutting down of trees. In the third and fourth centuries B.C. there used to be flourishing towns in this region. The land was well-irrigated, and there was a river running from the Aral Sea to the Caspian.

First came twenty years' study of the problem, research into the kinds of plants to grow, the weather conditions that had to be met, and which steps should be taken first. The moment work is begun even in semi-desert, the first thing to be attended to is the welfare of the people doing the work. They need shelter, food, supplies for the actual work, but above all they need water. The first step was to dam a river running from the south into the Aral Sea, and in this way to divert some of its water into the dry bed of the ancient river that used to connect the Aral Sea with the Caspian. However, this new supply was not allowed to run into the Caspian, and dams were erected across the dry river bed to contain the water when it had been diverted. With the new river brought to life, irrigation canals were dug to carry the water into the desert, so that, in effect, the workers were so deployed that the water was carried along with them as they advanced into the desert. At the same time, ahead of them went parties to sink shafts to tap the underground supplies, where these were known.

One of the causes of this part of Asia becoming desert, apart from the felling of the trees and the long dry summers, was the strong winds that regularly blow across it. To dig a canal is one thing. To prevent it from being filled up again by wind-blown sand is another problem altogether. The answer in such a case is to construct windbreaks, and this is best done by planting belts of trees of a

quick-growing kind. For these poplars were used, trees which grow well provided they can be kept watered. Something more was needed than this first line of defence. Something must be sown in the desert itself to prevent the winds and the wind-blown sand from driving with all their force on to the newly-planted belts of poplars.

A tree that grows there in the desert, without special watering, and which used to be abundant until it was so largely cut down for fuel in years past, is the black saxaul tree. This can send its roots down thirty feet, to the underground waters. It will grow to a height of twenty feet in ten years, so seeds of the black saxaul were collected and men mounted on camels scattered these seeds far and wide over the desert. Where necessary, the young trees were protected by screens made of reeds planted in the ground to keep the shifting sands from smothering them in the early stages of their growth.

Such measures can only represent the first steps. For the complete reclaiming of desert lands the soil must have returned to it the humus it has lost. This can only be understood when we remember how soils are made. In the first place there is rock, which is broken into particles by frost and by the abrasive action of wind. The particles are ground smaller and smaller by these natural forces to form first gravel, then sand and finally clay. Lichens are plants that can live on the face of rock, independently of soil. When these decay their remains serve to nourish mosses, which can live with very little soil. As the mosses decay, more vegetable matter is accumulating on the faces of the rocks or in the crevices between the rocks, or among the gravels and sands formed as the rocks break up. Small flowering plants can find enough nourishment from this to grow, and their decay provides in turn the humus in

which still larger plants can grow. So the vegetation slowly builds up as more and more vegetable matter decays and is added to the sand.

This is a very slow process, not only because it takes years for the larger plants to become established but also because the breakdown of the dead plant material does not occur in one season. A dead plant is first attacked by snails, slugs and millipedes, which break it into a finer form, different kinds of woodlice break the plant tissues into finer and finer particles for bacteria to work upon.

If you were to take a boxful of dried leaves, being careful to exclude all forms of animal life, the leaves would be little altered after several years. Suppose in a second box, the leaves have included with them a number of small animals such as woodlice, millipedes, mites and such like, the leaves would soon be reduced to a powder, always assuming that they are kept just sufficiently damp so that the animals living among them do not die from lack of moisture.

In the formation of soil, therefore, we need the sand, the vegetable matter and the animal life, and these, if left to work naturally, will give us the fertile soil needed to support life. Looking at it on a larger scale, a piece of barren stony ground left to itself, provided there is adequate moisture and a freedom from scouring winds, will become covered with vegetation and teeming with animal life, but it will take thousands of years to do it.

Reclaiming deserts must be a slow job, but nobody can afford to wait thousands of years, so methods must be found for speeding it up. In this connexion the work being done on the Australian deserts is of interest. There, as elsewhere, there are certain plants that eke out a living in dry soil. Left to themselves, these plants do not increase

in numbers and the land remains a desert. When sheep are allowed to browse them the shrubs do much the same thing as a privet hedge does when we clip it. New shoots sprout on the stems that are left. Provided they are not too heavily cropped, therefore, the shrubs benefit from being eaten by sheep.

They derive another benefit also. When the leaves fall from the shrubs to the ground they will, in course of time, decay and form humus. But this takes a long time. When sheep crop the leaves, they digest them. This means, they take from them those parts that are nourishing and the rest is voided as droppings. These fertilize the ground, and animal waste is converted into humus far more quickly than vegetable waste. Putting sheep among the desert plants achieves two ends therefore. It stimulates the plants to more rapid growth and the ground is more quickly fertilized.

This sounds too easy a solution to the problem and, in fact, it is not as easy as all that. When too many sheep are put on to a given area, they overcrop the vegetation. They kill it off and more desert land is the result. When too few sheep are put on it the plants are not stimulated enough to show any appreciable increase in growth, and the ground is not fertilized by their droppings to any marked extent. Only by careful study over a period of years, using test plots of ground, with different numbers of sheep and by studying the climate to see how the rainfall fits into this picture, will it be possible to decide what density of sheep per acre should be used to give the maximum results. This kind of research is now going on in the deserts of South Australia.

There are two things that must always be borne in mind when speaking of deserts and the reclaiming of desert lands. The first is that the study of deserts is barely out of its

infancy. It has not been going on for very long and there is still much to learn. The second is there are many different conditions of desert so that each area poses its special problems. The result is that when one tries to put the subject in simple terms and in a few words, the remarks are apt to be misleading. For example, the simplified picture just given of what is being done in the Australian deserts can be misleadingly optimistic. It may lead to the impression that it is only a matter of time before the vast area of desert or semi-desert that covers the greater part of the Australian continent can be made productive. The real story is that the investigations that have just been described affect only the semi-deserts, and even then only those on the fringes of the true deserts. These, it is true, offer large areas for sheep-grazing, and have already been so used. They can support a large population of sheep, but they will support only a small human population. Moreover, too often in the past too many sheep have been allowed to graze them, with the result that the vegetation, small enough to begin with, has been further depleted, and semi-desert has become more truly desert. The research going on at present is directed rather to seeing how, by wise management of the grazing, the maximum use can be made of the natural vegetation. And if this research can be said to have a second aim it is to prevent the spread of desert lands.

To a large extent, what has just been said of the Australian deserts can be said of all. There is a great deal of talk about reclaiming them which is over-optimistic. The hard truth is that there is a reasonable chance of reclaiming man-made deserts, and there is a reasonable chance of checking the spread of deserts. Little more can be hoped for than this.

No doubt any desert could be conquered if enough money and labour were spent on the task, but the cost would be too often prohibitive, and with the larger deserts it would take the resources of the whole of mankind to do the work and even then there would be no guarantee the work would be permanent. There is always this question of water-supply. It is possible to alter the weather locally, as, for example, by making wind-breaks. These break the winds up into eddies, thus reducing the extent to which the wind will erode the soil. Wind-breaks also reduce the force of the wind and by so doing lessen the amount of water the plants sheltered by it will lose. As soon as the water-loss from vegetation is checked the air behind the wind-break becomes that much more humid, and therefore more favourable to the growth of the plants themselves. A wind-break can therefore affect the weather locally.

Climate, on the other hand, is largely beyond human control. Where a desert is caused because a range of mountains takes all the rain out of the atmosphere, or is caused because the prevailing winds blow from the land to the sea, nothing can be done.

Geography has its influence in another way, and in examining this we see one of the greatest problems confronting those dealing with the Australian deserts. As we have seen, in many deserts there is water ten to sixty feet below the surface. This is no less true of some of the Australian deserts. It would seem a simple matter, in such instances, to sink bores and pump the water to the surface for irrigation purposes. These underground supplies are of two kinds. There are those of Australia and Africa in which the underground reservoirs might almost be called fossil water. That is, they are filled with water that has

accumulated over a period of thousands of years from rain-water seeping down through the ground above. Such reservoirs can only be used sparingly or their supplies would be exhausted in a relatively short number of years. In Asia and North America, the underground reservoirs are usually accumulated mainly from underground streams fed by melting snow and ice on near-by mountain ranges. They are replenished more quickly and the replenishment is continuous and independent of the amount of rain falling on the desert itself.

Use of desert lands has other practical problems, and these can be illustrated by a very simple example. In Australia, as we have seen, sheep can be pastured on semi-desert land. But cattle cannot be herded there. Cattle can just as readily feed in such areas, but then comes the problem of marketing them. The obvious way to do this is to drive the herds to market. This means driving them over long distances, and by the time they arrive at the market they will have lost so much weight and be so out of condition that they are almost unsaleable, or have to be sold at a loss. Attempts have been made to solve this problem by slaughtering the cattle on the spot and transporting the carcasses by air. The cost of air-transport makes this uneconomic.

In short, then, what we have to do is not to attempt the conquest of the deserts but to see how far they can be made to work for us in a limited capacity. Thus, research on the degree to which various fodder crops can grow under dry conditions shows that Russian thistle can grow under semi-arid conditions and that millet and Sudan grass will grow under more or less dry conditions. These can be used, therefore, in reclaiming deserts and for feeding livestock on otherwise desert lands. On the other hand, wheat and lucerne, two crops that are so important and

are so widely grown elsewhere, cannot tolerate the conditions of dryness found even in semi-deserts.

Where crops can be grown under dry conditions there is one distinct advantage to the farmer: he has to contend with fewer plant pests, such as moulds and mildews. In Israel the vineyards in the inland valleys are free of the

Colchicum, crocus of the Israeli desert

diseases that attack grapes elsewhere, and the plantations of oranges are much less affected by diseases than in other citrus-farms elsewhere in the world.

The state of Israel contains a high proportion of semi-desert and desert lands, and not surprisingly the Israelis have carried out a good deal of research into the use of these lands. One line of research has been to see how far desert plants can be used, instead of seeing how far desert

plants can be replaced. Some bushes are valuable as fodder, so efforts are directed towards increasing these by means of cuttings instead of waiting for them to multiply naturally by means of seeds. Another desert bush has a bark made of extremely strong fibres, which could possibly be used commercially. But the most striking example is seen in the discovery made about the bulbs of Colchicum. This is the name given to crocus-like plants, one of which grows wild in this country and is known as the autumn crocus. The corm—the swollen, bulb-like lower stem—contains a drug known as colchicine, used in medicine for the treatment of rheumatism and other ailments. The demand for colchicine is greater than the supply, but whereas the autumn crocus in this country grows in groups and its corms can be more readily collected, the Colchicum of the Israeli desert is few in numbers and the plants widely spaced. The labour and cost of collecting would, therefore, be considerable, and the more corms that were collected the sooner would the plant become too scarce to make the collection worthwhile. Then it was found, by chemical analysis, that the stem and the flowers contained six times more colchicine than the corms. This meant that the harvesting of the drug could be done at the cost of much less labour and the plant itself saved from extinction.

The Negev desert is part of Israel and it lies like an arrowhead thrust between the territories of Egypt and Jordan, which is one reason why it is so much in the political news. Among other reasons why it is important to Israel is that there is a Desert Research Station. There the Israeli scientists have been rediscovering the importance of dew. By "rediscovering" we mean that the importance of dew was known long ago, but that for centuries its use has been neglected. In the Book of Judges, in the Old

Testament, we read that Gideon asked God for a sign. He spread a fleece on the ground and in the morning when all the ground around it was dry he was able to wring a bowlful of water from the fleece. Apart from anything else, this showed him how much water could be collected from dew.

The ancient peoples of Israel made dew-mounds in the desert. They piled loose stones to a height of about a yard. Dew forms most a few feet up from the surface of the ground, so it condensed on the cold pebbles, filtered down through the piles of stones and formed a wet patch beneath them. When the sun rose high in the skies, and its heat parched the ground around, the wet patch was shaded from the sun's rays and remained damp. Trees planted among these dew-mounds were assured of a constant supply of moisture. In Palestine, there is no rain from early June until mid-September but the dews are heavy during this rainless period. This is recognized in the Hebrew liturgy by its regular daily prayers for dew in summer and rain in winter.

Where the ancient peoples used dew by rule-of-thumb methods the modern Israelis are bringing scientific research to their aid. The precipitation of dew varies from one locality to another, and the amount of dew falling in any one place depends on the topography, the nature of the soil, the kind of vegetation growing there, and whether or no there is any sort of irrigation. This means that the amount of dew likely to fall can be predicted by the use of dew-gauges, and to some extent the quantity can be controlled.

Sand dunes, which are a feature of deserts, contain much water trapped from dew. For a few seconds every morning, as the sun rises, they are covered with a hoar

frost and this quickly melts. Some of the water is evaporated but much of it seeps down into the heart of the dune.

In the soil itself there is a dew-horizon. This is a layer where the moisture drawn upwards by the heat of the sand meets the water from dew which has condensed and is seeping downwards. This dew-horizon is not at the same distance below the surface in all areas but it can be measured, and for each area crops can be grown with roots that reach down to the dew-horizon. By suitable planting crops can be grown that can be successful even when there is no rain. All that is needed is to know the depth of the dew-horizon and to know plants whose roots will reach down to it. Some plants are known to be dew-gluttons. Their leaves absorb dew from the air. This then travels downwards through the plant and is given off by the roots into the soil. With this knowledge, it is possible to use certain plants, the dew-gluttons, as wet-nurses to other plants grown alongside them. Other plants behave in the opposite way. They suck all the stored water from the dunes. Tamarisk is a well-known desert plant, and is one often used for constructing wind-breaks in deserts, but because it is a glutton for water stored in the ground it can only be used when irrigation is possible.

These few examples serve only to show some of the ways in which attempts are being made to reclaim land lost to desert and to stem the further growth of deserts already in existence before man began to till the lands. The deserts of the Middle East, and now the Sahara, have been or are being exploited for their oil. But Iraq, one of the centres of oil-production, also has irrigation schemes in hand. There have been large-scale reclaiming of deserts in the Kara Kum and Trans-Ural regions of the Soviet Union, and some in Pakistan and in India; and everywhere

deserts are being looked at with fresh attention. All such work must, however, be done on a long-term basis, and the knowledge of many sciences must be combined with the work of engineers. Moreover, experience gained in one part of the world may help in any new schemes being contemplated in other parts of the world. This is where Unesco has been able to play so valuable a part, not only by encouraging and helping, where these are necessary, but by making it possible to pool on an international scale the knowledge and experience gained so far.

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